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Electric Traction on the Suburban Lines of the London, Brighton and South Coast Ry.

By H. RAYNAR WILSON.*

After the surface-car lines that parallel the London, Brighton and South Coast Ry.—generally known as the London and Brighton Ry.—in the London area had passed from private into municipal control and had been converted from horse to electric traction, the railway company began to experience very serious competition. In 1903, the Directors requested their Consulting Electrical Engineer, Mr. Philip Dawson, M. Inst. E. E., to report on the whole question of the electrification of their railways.

As a result of this report, Mr. Dawson was instructed to prepare specifications for the electrification of what is known as the South London line, one of the many suburban lines of the London and Brighton Co., shown in Fig. 3. This line connects the London Bridge terminus in the southeast with the Victoria station in the west end and passes through East Brixton, Denmark Hill and Peckham Rye.

The decision as to what system to adopt was not arrived at until after the most careful examination and consideration of all that had been done hitherto and of the special problems involved in the electrification of this particular railway. Many London merchants reside at Brighton, for whose convenience there is a special service and one important point was that it was likely, if electrification proved a success on the suburban system, that it might afterwards be extended as far as Brighton. It was, then, in order to deal with a possible high-speed long-distance service that the single-phase system was adopted and it is generally considered that the results on the South London line have fully justified the installation of that system. Another important point was that the success of the South London experiment would lead to the electrification of the remainder of the suburban service, and the plans were therefore drawn up in that anticipation.

Tenders for the work were issued in 1905 and the contract was finally awarded early in 1906 to the Allgemeine Elektricitäts Gesellschaft, of Berlin. Experimental trains were run on the South London line early in 1909, and the full service was taken up in December of the same year.

The length of the route is 8.1 miles, equivalent to 20½ miles of electrified single track. The average distance between stations is 4,590 ft., while the shortest distance between any two stations is 1,386 ft. The gradients and curves are unfavorable. Notwithstanding the difficulties, the journey, including 20-second stops at the stations, is easily accomplished in 24 minutes.

The financial results on the South London line since the electric service was opened have been very satisfactory. The railway company lost, on this length alone, in consequence of trolley-car competition, over 5,000,000 passengers in a very few years. Although little alteration was made in the fares, the whole of the lost traffic has since come back and the numbers are increasing daily.

The success of the first experiment was considered so great that in May of last year the Directors decided to extend the electrification, the new sections being (1) the portion between Peckham Rye and West Norwood, (2) the line from Victoria to West Norwood and thence to the Crystal Palace. This brings up the total amount of electrified single track to 62 miles.

The rolling stock on the South London line consists of 16 motor coaches, each equipped with four motors with a one-hour rating of 115 HP., or 57 HP. continuously, for a temperature rise in no part exceeding 75° C. In the middle of the day, the trains are made up of two coaches—one motor and one trailer—while in the morning and evening two such trains are run coupled together.

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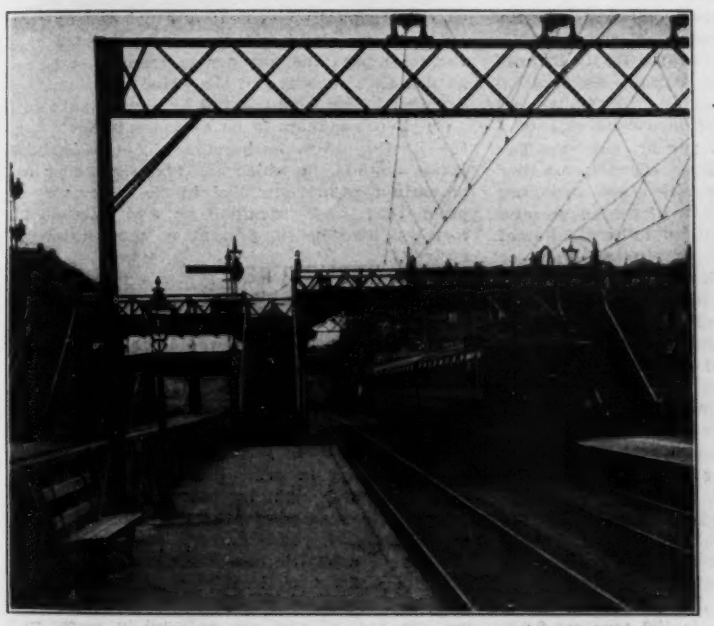

FIG. 1. A THREE-CAR ELECTRIC TRAIN OF THE SOUTH LONDON LINE, PASSING UNDER FOOTBRIDGE AT WANDSWORTH ROAD.

FIG. 2. TYPICAL SINGLE-PHASE OVERHEAD CONSTRUCTION OF THE LONDON, BRIGHTON AND SOUTH COAST RY.: EAST END OF DENMARK HILL TUNNEL, SOUTH LONDON LINE.

The rolling stock for the extension consists of 30 motor coaches, each equipped with four motors rated at 175 HP. for one hour and 100 HP. continuously. One of these motor coaches will carry two trailer cars, thus making up a three-car train. In the rush hours, six-car trains will be run.

It is interesting to note that all these cars are built in the usual English style with compartments and side doors. It was considered that the end-door type would not have enabled sufficiently quick exit and entrance at the terminals.

Electric energy for running the trains is purchased from a private corporation and delivered to the railway company at two points—Queens Road and Peckham Rye Junction—where the current is metered and paid for.

In consequence of the Board of Trade rules, suspended every 10 ft. (Fig. 1). The contact wire itself is of copper, round in section but with two sharp grooves on either side, to which the clips supporting the wire are fixed. The whole insulation is of porcelain and a special form of insulator has been used (Fig. 3) which has given good satisfaction. The design of this insulator was fixed only after tests, extending over nearly 12 months. No tightening device is used for the conductor wires and experience has shown that, in the case of the English climate at any rate, such devices are entirely unnecessary. The bow collectors are of special design made to operate at varying heights, there being a difference of 6 ft. between the highest and lowest working position. The bows are equipped with aluminum contact strips having a deep groove filled with grease. These have given good service. All the wear is practically taken by these strips and the wear on the copper contact wires, after these 18 months' running, is inappreciable.

FIG. 3. DIAGRAM PLAN OF THE LONDON, BRIGHTON AND SOUTH COAST RAILWAY LINES.

Current is supplied at a normal line voltage of 6,700 and at 25 cycles. It is stated that the transmission losses between the distributing stations, where the current is metered, and the trains has been kept to about 3%. The general energy consumption for the system is claimed to compare quite favorably with that on any direct-current line.

The acceleration obtained is also satisfactory, being equal to that obtained on most of the continuous current railways in Great Britain. The average acceleration from 0 to 30 miles an hour is at the rate of 1 mi. per hr. per sec. The energy consumption per ton mile (not including weight of passengers and with no mileage allowed for empty running or switching and including all the energy used in the repair shops and the leakages metered) for the first eight months of 1910 amounted to 75.4 watt hours per ton mile. It must also be borne in mind in this connection that all trains are local and therefore the line is worked under less favorable conditions than railways which have a number of express trains.

The total weight of an empty four-car train, for the South London line, is 150 tons (of 2,240 lbs.) and of this, the electrical equipment, including all the cables for lighting, lighting fixtures, motor-driven air compressor and all electrical gear, boosters, etc., amounts to 18 tons. For the new extension, the weight of a three-car train is 102 tons and the weight of the electrical equipment on the same basis as above, is 19 tons. The energy consumption on the train during trial running on the South London line was 63.1 watt hours per ton mile, measured on the train.

It is claimed that 18 months' experience, with the average distance run during the first 12 months by every one of the motor coaches owned, including all spare cars, of over 58,000 miles, shows that there is no reason to expect that the maintenance charges here will be any greater with single-phase than elsewhere with a direct-current system.

limiting the drop in potential in the return circuits, series-booster transformers are located at various points along the line and are connected by booster cables to the distributing station at Peckham Rye. Besides this, so-called distributing cables are run the whole length of the electrified line, one being in parallel with the overhead conductors and connected to them at each switch house, while the other is bonded to the rails. Besides these cables there are telephone wires running along the line connecting the various switch cables.

Fears were expressed that any overhead line would greatly interfere with the sight of the signals, but experience has not shown that this is the case.

Great attention was paid to the design of overhead construction and the results of eighteen months' commercial working have been entirely satisfactory. The construction adopted was the cradled catenary type, the contact wire being

The Allgemeine Elektricitäts Gesellschaft secured the contract for the electrical equipment of the recent extensions noted. The work on these constitutes a notable record, as 46½ miles of track has been equipped and 30 trains have been built in nine months from placing the orders.

The repair shops and carriage sheds at Peckham Rye, as well as the switch cabin buildings and the new carriage sheds for electrical stock at Norwood Junction, were designed and carried out under the supervision of Mr. Charles L. Morgan, the company's Chief Civil Engineer, while Mr. Philip Dawson, as the Consulting Electrical Engineer, was responsible for the whole of the work generally.

The Scale Paraffine Test as Applied to Bituminous Road Compounds.

By A. W. DOW, M. Am. Inst. Chem. E., and FRANCIS P. SMITH,* M. Am. Soc. C. E.

During the past year a number of attempts have been made to use the scale paraffine test as an index of the value of different road compounds. Certain large purchasers have even gone so far as to draw up specifications for these materials in which the price to be paid for them depended upon the amount of scale paraffine which they showed on analysis in their laboratories.

Such a practice is, of course, well within the rights of any buyer and we are only concerned with that phase of it which seems to indicate that the test for scale paraffine is a correct measure of the road-making value of bituminous compounds intended for that purpose.

From a very wide experience in the mining, refining and testing of all classes of asphalts, and the manufacture of bituminous compounds intended for road work and the practical laying of sheet asphalt pavement and bituminous road surfaces, we are decidedly of the opinion that the scale paraffine test per se should not be regarded as a measure of the value of bituminous compounds for road-making or paving purposes:

(1) Because there is no evidence to show that the finding of scale paraffine by the modified Holde method, in which the material under examination is first distilled in the laboratory is proof that scale paraffine or any detrimental form of paraffine is present in the bituminous material.

(2) Because there is no evidence to prove that paraffine of any kind is a deleterious constituent for a bituminous road cement.

We recognize that the value which has been ascribed to this test has undoubtedly arisen largely from the fact that the residuums obtained by the distillation of paraffine petroleums, similar to those produced in the Pennsylvania fields, were of a greasy nature and almost wholly lacking in cementing or binding value. Such oils are high in paraffine and consist largely of compounds of the paraffine series. On the other hand, residuums obtained by the distillation of asphaltic oils which are very low in paraffine and consist largely of a different series of compounds have a very high cementing value are not greasy, and are universally recognized as being eminently suitable for road building. Natural asphalts are also low in scale paraffine. From a consideration of these facts alone, it is very easy to see how the conclusion as to the pernicious effect of scale paraffine was arrived at. Unfortunately for the correctness of this conclusion, we are in possession of a large number of other facts which seem to very clearly indicate that the amount of scale paraffine per se is not nearly so important as the condition in which it exists in the bituminous compound and that this is dependent upon the ability of the other constituents of the compound to dissolve and assimilate the paraffine.

Paraffine residuums high in scale paraffine have been successfully used as fluxes for softening hard asphalts, and some of our best and oldest

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sheet asphalt pavements have been laid with such combinations.

Richardson, on page 300 of the 1908 edition of his work, "The Modern Asphalt Pavement," says; "The successful use of it (paraffine residuum) in many pavements laid 20 years ago, which are now in perfect repair, is the best evidence that it is satisfactory." In fact, prior to the year 1900 it is safe to say that 90% of all the asphalt pavements laid were manufactured with paraffine petroleum residuum and that approximately 50% of all modern pavements are also manufactured with the same class of residuum. The earlier residuums often contained as high as 20% of scale paraffine, as shown by Mr. Richardson's analyses of them, and as 25 parts of residuum to 100 parts of asphalt were commonly used, the asphalt cements must have frequently contained as high as 4% of scale paraffine. Such asphalt cements made from Trinidad asphalt, which was one of the earliest asphalts used, would only contain approximately 65% of bitumen, so that the percentage of scale paraffine in the bitumen itself must have run as high as 6% in many instances.

It is true that in this case we are considering mixtures of asphaltic and paraffine compounds, but all of the bituminous compounds for road work in reality consist of just such mixtures. The petroleums found in the United States have been broadly separated into three classes:

Paraffine petroleums,
Semi-asphaltic petroleums,
Asphaltic petroleums.

With the exception of the fluxed natural asphalts, the bulk of the bituminous road compounds are being manufactured from semi-asphaltic petroleums. These are, as their name indicates, midway between the paraffine and asphaltic petroleums and partake of the characteristics of each. The fluxed natural asphalts are combinations of asphalt and petroleum residuum obtained either from paraffine or semi-asphaltic petroleums. In either case, therefore, we have to deal with compounds in which scale paraffine may exist in combination with asphaltic compounds.

Maberry (Jour. Am. Chem. Soc., Vol. XXVIII., No. 3, p. 415) has come to the conclusion that all petroleums (and all asphalts are undoubtedly derived from petroleum by natural or artificial means) contain the same constituents and that their different properties are due to the varying proportions of these constituents. Our investigations of a large number of petroleums and asphalts confirm this conclusion. Even the natural asphalts which we have examined all contain determinable amounts of scale paraffine. If only those petroleums of the Pennsylvania type contained paraffine and if these residuums were incapable of yielding satisfactory compounds when mixed with asphaltic compounds, it would be logical to discriminate against those compounds which contained any paraffine scale.

TABLE II.—PENETRATION AND DUCTILITY TESTS OF CERTAIN ASPHALTIC CEMENTS SHOWN IN TABLE I. COMPARED WITH SIMILAR ASPHALT CEMENTS MADE FROM THE SAME INGREDIENTS BUT TO WHICH NO SCALE PARAFFINE HAD BEEN ADDED.

		Par-affine.	Penetrations 32° F.	77° F.	90° F.	Ratio.	Ductility at 77° F.
Bermudez A. C.	1-d	4.0%	15	77	156	1—5.1—10.4	34.0 cms.
" "	1-x	None	17	78	120	1—4.6— 7.0	35.0 "
" "	2-b	2.0%	16	78	111	1—4.9— 6.9	38.0 "
" "	2-x	None	15	74	110	1—4.9— 7.3	39.0 "
California A. C.	3-f	6.0%	16	68	90	1—4.3— 5.6	17.0 "
" "	3-x	None	14	72	82	1—5.1— 5.9	63.0 "
							Ductility at 50° F.
" "	4-f	6.0%	14	65	127	1—4.6— 9.7	77.5 cms.
" "	4-x	None	18	75	102	1—4.2— 5.7	20.0 "

It is evident, however, from the foregoing that the problem is much more complicated than this. It cannot even be considered as wholly a question of the allowable percentage of paraffine, for experience has shown that of two residuums one may give good results as a flux with a certain asphalt and the other may not, and in many instances the one which gives the best results will contain the most paraffine.

The present generally accepted method of determining scale paraffine by the modified Holde method, in which the material under examination is first distilled in the laboratory, is far from satisfactory. It is difficult to get two operators to agree in their results and we are strongly of the opinion that the scale paraffine found by this method does not necessarily exist as such in the material examined.

In connection with this paper we have carried on a number of experiments and investigations, some of the results of which are described below. Other experiments are in progress, which we hope to make the basis of a future article.

Experiments on the Addition of Scale Paraffine to Asphaltic Cements.

In these experiments, four asphalt cements were prepared whose value and suitability for paving purposes has been unquestionably demonstrated by practical experience covering many years. For purposes of comparison it was desirable to have asphalt cements consisting as nearly as possible of pure bitumen uncontaminated with any considerable amount of mineral matter. Refined Bermudez asphalt was selected as typical of the natural asphalt class and California D grade as typical of the best class of asphalts made from petroleum. Two series of asphalt cements were made from each of these refined asphalts by fluxing them with two different kinds of residuum. Both of these residuums have been used in combination with these asphalts for paving purposes in a number of cities in the United States with wholly satisfactory results. The consistency of the asphalt cements so prepared was that usually employed in testing combinations of these materials for use in sheet-asphalt paving work. This consistency was chosen rather than the softer ones usually used in bituminous road work in order that the physical properties of the cements might be more readily tested and compared. The percentage of paraffine scale present in the various ingredients was determined by us by the modified Holde method, in which the material under examination is first distilled in the laboratory, as follows:

Refined Bermudez Asphalt	0.17%
California D Grade Asphalt	0.86%
Paraffine Residuum	3.02%
California Asphaltic Residuum	0.19%

The following proportions by weight of refined asphalt and residuum were used:

Number	Bermudez 1	Bermudez 2	California 3	California 4
Refined Asphalt	100	100	100	100
Paraffine Residuum	15	...	6	...
California Asphaltic Residuum	...	30	...	15

From each of these four asphalt cements six others were prepared, marked a, b, c, d, e, and f. These consisted of the original asphalt cement to which had been added, by melting and thorough stirring, sufficient scale paraffine to bring the paraffine contents up to 1, 2, 3, 4, 5 and 6%, respectively. The four "f" cements were duplicated in a series marked "g" using the same percentage of each of the same ingredients; the only difference being that the scale paraffine was first dissolved in the residuum by melting and stirring and this mixture was then added to the melted refined asphalt and thoroughly stirred. This was done to determine whether the method of adding the paraffine affected the physical qualities of the asphalt cement. The physical tests made on these various cements are given in the following table. It should be borne in mind that the cements marked "Bermudez Asphalt Cement No. 1," "Bermudez Asphalt Cement No. 2," "California Asphalt Cement No. 3," and "California Asphalt Cement No. 4" were typical of the best quality of asphalt cements for paving work as has been shown in practice covering a long series of years, and the results of the physical tests made on them are therefore worthy of careful attention. Susceptibility to changes in temperature was tested by obtaining the penetration of the various asphalt cements at different temperatures. The maximum temperature of 90° F. was selected instead of the more customary ones of 100° F. or 115° F. to avoid the possibility of finding that some cements were too soft to test at these higher temperatures. The ductility of the series commencing with California Asphalt Cement No. 4 was determined at 50° F. instead of at 77° F., as at the latter temperature some of them had a ductility of over 100 cms., which was beyond the capacity of our apparatus to correctly record.

In view of the fact that the addition of scale paraffine raised the penetration of the asphalt cements considerably, we thought it desirable to prepare one additional sample for each series, made from exactly the same ingredients but containing no added scale paraffine and having a penetration approximating that of some of the softer cements. This was done in order that we might more closely check up any physical changes due to the addition of the scale paraffine. These additional samples were marked 1-x, 2-x, 3-x and 4-x, respectively, and were made up as follows:

	1-x	2-x	3-x	4-x
Refined Bermudez Asphalt	100	100	...	...
California D Grade Asphalt	...	...	100	100
Paraffine Residuum	20	...	11	...
Cal. Asp. Residuum	...	40	...	20
Penetration at 77° F.	78	74	72	73

Comparing these with the paraffine scale cements nearest to them in penetration, we obtained the results shown in Table II.

From an inspection of all these results we see:

(1) That the addition of small amounts of hard paraffine scale raised the penetration of the asphalt cements very considerably.

(2) That it also increased the susceptibility of the asphalt cements to changes in temperature,

TABLE I.—PENETRATIONS AND DUCTILITY OF ASPHALTIC CEMENTS TO WHICH STATED AMOUNTS OF PARAFFINE SCALE HAD BEEN ADDED, COMPARED WITH ORIGINAL CEMENTS.

		Par-affine.	Penetrations 32° F.	77° F.	90° F.	Ratio.	Ductility at 77° F.
Bermudez A. C. No.	1	0.54%	14	56	76	1—4.0— 5.43	32.0 cms.
" "	1-a	1.00%	12	55	86	1—4.6— 7.17	33.5 "
" "	1-b	2.00%	13	62	110	1—4.8— 8.46	34.0 "
" "	1-c	3.00%	14	70	132	1—5.0— 9.43	35.0 "
" "	1-d	4.00%	15	77	156	1—5.1—10.40	34.0 "
" "	1-e	5.00%	16	82	168	1—5.1—10.50	35.5 "
" "	1-f	6.00%	17	86	184	1—5.1—10.80	33.0 "
" "	1-g	6.00%	17	85	176	1—5.0—10.35	32.0 "
Bermudez A. C. No.	2	0.17%	12	52	82	1—4.3— 6.83	33.0 "
" "	2-a	1.00%	15	65	101	1—4.3— 6.73	34.0 "
" "	2-b	2.00%	16	78	111	1—4.9— 6.93	38.0 "
" "	2-c	3.00%	17	90	120	1—5.3— 7.06	32.0 "
" "	2-d	4.00%	18	96	145	1—5.3— 8.06	41.0 "
" "	2-e	5.00%	19	105	151	1—5.5— 7.93	34.0 "
" "	2-f	6.00%	20	109	192	1—5.5— 9.60	39.0 "
" "	2-g	6.00%	17	132	225	1—7.8—13.20	52.0 "
California A. C. No.	3	0.98%	10	47	52	1—4.7— 5.20	39.0 "
" "	3-a	1.00%	14	52	54	1—3.7— 3.85	33.0 "
" "	3-b	2.00%	14	58	64	1—4.1— 4.57	48.0 "
" "	3-c	3.00%	15	60	70	1—4.0— 4.66	23.0 "
" "	3-d	4.00%	15	62	74	1—4.1— 4.93	23.0 "
" "	3-e	5.00%	15	66	82	1—4.4— 5.47	17.0 "
" "	3-f	6.00%	16	68	90	1—4.3— 5.62	17.0 "
" "	3-g	6.00%	12	67	92	1—5.6— 7.66	13.0 "
							Ductility at 50° F.
California A. C. No.	4	0.77%	14	47	69	1—3.4— 4.93	10.0 cms.
" "	4-a	1.00%	13	53	83	1—4.1— 6.38	9.0 "
" "	4-b	2.00%	13	57	94	1—4.4— 7.23	8.5 "
" "	4-c	3.00%	13	59	108	1—4.5— 8.15	9.5 "
" "	4-d	4.00%	13	61	112	1—4.7— 8.61	8.5 "
" "	4-e	5.00%	13	63	116	1—4.8— 8.92	7.0 "
" "	4-f	6.00%	13	64	126	1—4.9— 9.69	7.0 "
	4-g	6.00%	14	65	127	1—4.6— 9.07	7.5 "

(3) That in some cases it affected the ductility of the asphalt cements very materially and that in others it did not.

(4) That the paraffine residuum gave practically the same results as the asphaltic residuum with Bermudez asphalt, but very different results with the California asphalt.

These results are possibly open to criticism on the ground that we have questioned whether the paraffine scale found by analysis was really present as such in the compounds examined. It was impossible, however, to procure residuums with sufficiently high paraffine contents to enable us to prepare from them asphalt cements of 50 penetration containing as high as 6% of paraffine. Even had we been able to do so, it would have been impossible to prepare the extended and graduated series which we have shown without the addition in some cases of varying quantities of a low paraffine residuum. This would have vitiated our comparative tests. In order to test comparative ductilities, which test we believe measures more nearly than any other the cementing value of bituminous compounds, it was of course necessary to bring the cements to approximately the same penetration.

If any of the paraffine series exert a deleterious effect on bituminous compounds intended for paving work, we believe that it is generally, although wrongly, assumed that the scale paraffine is the worst in this respect. We therefore felt that in using scale paraffine we were making the tests as severe and searching as it was possible to make them and that we were putting into the bituminous compounds the very constituent found by analysis and by which they were being judged.

As the amount of paraffine allowed by most specifications falls considerably below 6%, and as it would be difficult to satisfactorily incorporate a much larger per cent of paraffine than this in a bituminous compound, we did not endeavor to prepare asphalt cements containing more than 6% of scale paraffine.

A number of the experimental asphalt cements were analyzed for paraffine scale as an additional check upon the work. The results which we obtained in this manner are shown by Table III.

TABLE III.—RESULTS OF DETERMINATIONS OF PARAFFINE SCALE CONTENTS OF EXPERIMENTAL ASPHALTIC CEMENTS.

	Calculated Paraffine.	Found Paraffine.
Bermudez Asphalt Cement 1-f.....	6%	5.01%
Bermudez Asphalt Cement 2-f.....	6%	6.11%
California Asphalt Cement 3-f.....	6%	6.23%
California Asphalt Cement 4-f.....	6%	6.29%

The bearing of these results upon present methods of determining paraffine scale will be discussed later.

Recognizing that the foregoing series of tests were too limited to prove all the tentative conclusions that were apparently to be drawn from them, we extended the scope of our investigations in order if possible to fully substantiate or disprove them. In this connection we will take up each one of the tentative conclusions separately and discuss our additional experiments relative to them.

(1) That the addition of small amounts of hard paraffine scale raised the penetration of the asphalt cements very considerably.

This conclusion was corroborated by a number of additional tests, the results of which hardly seem worth recording here in detail.

(2) That the addition of small amounts of hard paraffine scale increased the susceptibility of the asphalt cements to changes in temperature.

This susceptibility, if carried too far, might be regarded as seriously affecting the value of a bituminous compound for paving purposes and was therefore deemed worthy of careful attention. We appreciate that our previous experiments were confined to four different types of asphalt cement in which only two different refined asphalts were used. We accordingly made comparative tests of Bermudez, California, Texas and Mexican asphalt cements prepared in the ordinary manner without the addition of scale paraffine. These are shown by Table IV., together with the amount of scale paraffine which we found in them.

TABLE IV.—PENETRATIONS AND DUCTILITIES OF VARIOUS ASPHALTIC CEMENTS TO WHICH SCALE PARAFFINE HAD NOT BEEN ADDED.

	Paraffine.	Penetrations 32° F.	77° F.	115° F.	Ratio.	Ductility at 77° F.
Bermudez A. C.....	0.54%	12	50	265	1—4.2—22.1	52 cms.
California A. C.....	0.98%	10	50	338	1—5.0—33.8	125 "
Texas A. C.....	0.66%	27	50	178	1—1.9— 6.6	9 "
Mexican A. C.....	1.32%	10	50	258	1—5.0—25.8	95 "
Bermudez Road Com.....	1.54%	30	141	560	1—4.7—18.7	56 "

The Bermudez Road Compound, which shows the greatest amount of paraffine, is one of the least susceptible to temperature changes. The Mexican, which is the next highest in paraffine, is one of the most susceptible to temperature changes. The California asphalt cement, which comes next in paraffine, is the most susceptible of all. The Texas asphalt cement, which comes next in paraffine, is the least susceptible of all, and the Bermudez asphalt cement, which is the lowest in paraffine, shows a susceptibility only slightly less than that of the Mexican. Of the two Bermudez compounds, the one containing the most paraffine is the least susceptible to temperature changes.

It is evident from the above that the percentage of paraffine scale in an asphalt cement bears no definite relation to its susceptibility to changes in temperature and that our first tentative conclusions to that effect are not borne out by further investigations.

(3) That in some cases the addition of small amounts of paraffine scale affected the ductility of some asphalt cements very materially and that in others it did not.

The results shown under the discussion of tentative conclusion No. 2 substantiate our first results and show that the ductility or cementing value of an asphalt cement bears no relation to its paraffine contents. This is further confirmed by tests which we made on two residual products intended for road use which were produced by different methods from the same petroleum and which contained different percentages of paraffine scale.

TABLE V.—PENETRATION AND DUCTILITY TESTS OF TWO RESIDUAL PRODUCTS FROM THE SAME PETROLEUM, CONTAINING DIFFERENT PERCENTAGES OF PARAFFINE.

	Penetration at 77° F.	Pfn.	Ductility at 77° F.
Asphalt Cement No. 1....	103	2.39%	34.0 cms.
Asphalt Cement No. 2....	134	2.05%	8.5 cms.

In this case the asphalt cement showing the higher percentage of paraffine showed also the higher ductility and cementing value.

In certain other cases, Table VI., we find that some of the commercial Texas asphalts when fluxed with a high paraffine residuum give a much more ductile and cementitious cement than when fluxed with a semi-asphaltic residuum low in paraffine.

TABLE VI.—COMPARATIVE TESTS OF A COMMERCIAL TEXAS ASPHALT FLUXED WITH HIGH AND LOW PARAFFINE RESIDUUMS.

	A	B
Texas Asphalt (0.66% scale paraffine)	100 parts	100 parts
Paraffine Residuum (3.50% scale paraffine)	12 parts	...
Texas Residuum (0.40% scale paraffine)	...	15 parts
Penetration at 77° F.....	50	52
Ductility at 77° F.....	35 cms.	10.5 cms.
Scale Paraffine in Asphalt Cement (calculated)	0.964%	0.626%

In this experiment not only is the cement containing the highest amount of scale paraffine the most ductile and cementitious but the importance of a careful selection of the residuum to be used as a flux is again demonstrated even more clearly than in Table No. I.

Apart from the question as to the accuracy of present methods for determining paraffine scale, we believe that the results which we have shown clearly demonstrate the absolute folly of attempting to judge the paving value of bituminous compounds by means of the scale paraffine test.

Experiments Relative to Present Methods for Determining Scale Paraffine.

The continuous disagreement in the results obtained at different laboratories where this test is conducted by a prescribed method is evidence sufficient that in its present state it should not be looked upon as a standard test and one upon which materials may with justice be accepted or rejected.

With a view of determining the causes of these discrepancies if possible, we ran a series of paraffine analyses on the same material. All of these analyses were made in accordance with the method given by the Bituminous Committee of the American Society of Civil Engineers for the determination of paraffine, but in running them we made certain variations in the details of manipulation where these were not specifically described. Such variations could reasonably be considered as immaterial and are such as might readily occur in any laboratory and in no way constitute a departure from the instructions given. As will be seen, they only relate to the method of obtaining the distillate. As Holde has exhaustively discussed the variations resulting from modifications in the solutions and the temperature for precipitating the paraffine in his article "Determination of Paraffine in High Distillates from Petroleum" (Mitt. k. t. Versuchsanst zu Berlin 14 (4) 211-221), we have not considered it necessary to duplicate or extend his work. We give below the published description of the method referred to.

Compounds prepared from petroleum or natural pitches; Paraffine:

One hundred grams or less of the compound is distilled rapidly in a retort to dry coke; 5 grams of the well mixed distillate is stirred in a 2-oz. flask with 25 cc Squibb's absolute ether. After mixing thoroughly, 25 cc Squibb's absolute alcohol is added and the flask packed closely in a freezing mixture of finely crushed ice and salt for at least 30 minutes. Filter the precipitate quickly by means of a suction pump, using a 575 C. S. & S. 9 cm. hardened filter paper. Rinse and wash the flask and precipitate (with 1 to 1 Squibb's alcohol and ether mixture cooled to minus 17° C.) until free from oil (50 cc of washing solution is usually sufficient). When sucked dry remove paper. Transfer waxy precipitate to small glass dish. Evaporate on a steam bath and weigh paraffine remaining on dish.

Calculation: Weight of paraffine divided by weight of distillate taken and multiplied by per cent. of total distillate produced from original sample equals per cent. of paraffine.

As stated, the results recorded in Table VII. were obtained on only one sample of road cement, chosen particularly because of its high per cent. of scale paraffine and because it was the only material on which a complete series of tests had been made. These results, however, are fully substantiated by similar tests on many other materials, some of which show much greater variations.

In tests a, b and c the distillation was made with a curved condenser, as shown in Fig. 1. In tests d, e and f a straight condenser, as shown in Fig. 2, was used. In timing the distillations the watch was started when the burner was lighted. The distillation was considered complete when not more than one drop per minute came over.

All distillations of the material under examination were made in the same half-pint cast-iron retort, exactly 50 grams being taken for distillation each time. In the first series of tests a curved distilling tube ¼-in. internal diameter and 20 ins. long was used (Fig. 1). In the second series of tests the distilling tube was arranged on the retort as may be seen in Fig. 2.

TABLE VII.—TESTS OF A SINGLE SAMPLE OF ROAD CEMENT, HIGH IN SCALE PARAFFINE.

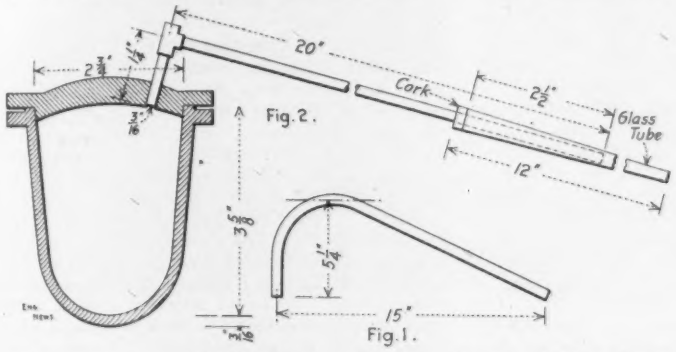
	No. of burners.	1st drop.	Total time distillation.	Coke.	Distillate.	Paraffine.	
a.....	1	15 min.	35 min.	36%	60.0%	1.42%	1.36%
b.....	2	12 "	30 "	30%	63.3%	2.09%	1.84%
c.....	3	10 "	20 "	24%	64.0%	2.65%	2.30%
d.....	1	11 "	35 "	30%	66.2%	1.51%	1.46%
e.....	2	9 "	20 "	24%	70.0%	2.48%	2.60%
f.....	3	5 "	13 "	22%	72.4%	2.74%	2.93%

The heat used was from 1, 2 or 3 Tyrell's burners each giving a flame 12 ins. in height. When more than one burner was used they were held together so as to produce a single large flame. The paraffine in all cases was determined by the specified method in the distillates, the per cent. being calculated by dividing the weight of paraffine found by the weight of distillate taken and multiplying by the per cent. of distillate actually condensed from the distillation. It will be seen from these results:

(1) That with the same temperature the distillation with the curved tube, Fig. 1, took appreciably longer.

(2) That the higher the temperature of distillation the larger the quantity of scale paraffine found.

(3) By comparing the results in the first and second series, it is seen that the per cent. of paraffine is the same when the temperatures are alike rather than when the time of distillation is the same. The various results obtained on this one sample, due wholly to slight changes made in the method of distillation, well illustrate with what care a standard method must be described to produce anything like concordant results. In fact it is rather doubtful whether it is possible to describe the method with sufficient accuracy to make it applicable to the determination of scale paraffine in all classes of road materials. The New York State Highway Commission, in describing its method for making this test, specifies the same iron retort and tee condenser of ¼-in. iron pipe 20 ins. long, shown in Fig. 2, and requires that the distillation be completed in less than 25 minutes, but it is seen that even this description is not sufficiently accurate to insure uniformity in results. We understand that this commission in making official tests often carries on the distillation so that it is completed in less than 20 minutes. This we believe is hardly justifiable in view of the above results, especially as contractors are penalized at the rate of ½-ct. per gal. for every 0.5% of paraffine in excess of 3.7% whenever the paraffine contents as determined in the laboratory of the Commission exceed that amount.



FIGS. 1 AND 2. CONDENSERS USED IN MAKING DISTILLATION TESTS OF PARAFFINE.

In examining the above results we naturally ask which one represents the proper percentage of scale paraffine contained in the original material and is scale paraffine formed by distilling at a high heat or does the distillation carried on at a lower temperature destroy scale paraffine that may be contained in the original material? We have not been able as yet to investigate these points sufficiently to answer definitely the queries propounded. In Table III., however, we show results which accord closely with the theoretical. These results were obtained with a moderate heat and a curved pipe condenser and we therefore feel justified in assuming that method to be the most correct. Test b and e in Table VII. were conducted by this method, and assuming them to be correct we see that by extremely slow (35-minute) and by extremely quick (20-minute) distillation, results are obtained which are too low and too high, respectively. We also find that with the same size of flame the position of the burner under the retort has an important influence on the amount of scale paraffine per cent. in the distillate. We have not as yet investigated this matter sufficiently to give any accurate comprehensive data concerning it, but it is a fact that a marked difference can readily be perceived in the character of the distillates obtained when the retort is placed in the flame about an inch above the top of the burner and when it is placed 4 ins. above the top of the same burner.

Besides the above discrepancies which we find in the test for scale paraffine, there is also a dispute as to how the results should be calculated. A large consumer insists that the paraffine should be calculated by dividing the weight of paraffine obtained by the number of grams of distillate taken for freezing and multiplying this result by the total per cent. of distillation products obtained from the original sample, as determined by subtracting the weight of coke expressed in percentage from 100%. We believe that this method is open to criticism and that it gives a larger per cent. of paraffine scale than is actually contained in the material. To justify such a method of calculation it must be assumed that scale paraffine escapes condensation in the course of distillation. This should not be the case if the distilling tube is conducted into a flask immersed in cold water. There is often considerable difference between the amount obtained by subtracting the per cent. of coke from 100 and the actual per cent. of distillate as determined by weighing the distillate. This difference represents the non-condensable gas formed during the distillation at high temperature, and this gas certainly cannot contain scale paraffine.

Scale paraffine boiling at a very high temperature is very easily condensed and there is no danger of losing any in the form of vapor, so that the more incomplete the condensation the more concentrated the distillate becomes in paraffine. If now the calculation is made on the per cent. of total loss from the retort, it is seen that the per cent. paraffine may be diminished or increased by more or less careful distillation. If on the other hand the calculation is made on the actual distillate condensed, such great care need not be exercised in the distillation. The only just method, therefore, of calculating the scale paraffine found, is by dividing the weight of paraffine obtained by the number of grams of distillate taken for freezing and multiplying the result by the percentage of distillate actually condensed from the original sample. Unless otherwise stated, all paraffine determinations made by us and given in the article were made by the method described for test b, Table VII.

Summary.

It is apparent that there is no evidence to be deduced either from practical experience or laboratory experiments that goes to prove that paraffine in any form is a detrimental ingredient in bituminous paving cements or road binders. On the contrary, from a theoretical point of view paraffine hydrocarbons are beneficial as they are more stable than the hydrocarbons of any other series, and therefore bituminous cements containing them would naturally be expected to age less in course of time. Moreover, scale paraffine by itself when used as a cementing material gives some very remarkable results. It is quite malleable at ordinary temperatures and does not become as brittle by cold or as liquid by heat up to a certain point as do the asphalts themselves.

Paraffine when in admixture with asphaltum loses its crystalline properties and becomes an amorphous semi-liquid constituent of the mixture. This is evidenced by the high penetration at 77° and 90° F. of the cements to which paraffine has been added. Industrial chemistry affords many illustrations of this phenomenon, among which is the loss of identity of sugar in molasses and the difficulty of crystallizing salts from a mother liquor containing certain amorphous organic substances in solution.

Apart from the question as to whether the scale paraffine formed by analysis really exists as such in the compound examined, we find that its effect upon an asphalt or bituminous paving material is unquestionably entirely dependent upon the state in which it exists in that compound. Up to 6% at least of scale paraffine, if in a suitable state of combination, evidently does not in any way injure them. The question of complete solution of the various constituents in each other is a very complicated one when the number of the different compounds present in paving cements is considered. We find that the physical properties of a bituminous binding material are not at all dependent upon its individual constituents but rather upon the chemico-physical combination of these ingredients. Mere chemical analysis in the present state of our knowledge will not enable us to predict the physical characteristics of the materials examined and it is evident that we must make both physical and chemical tests before we can determine the fitness of bituminous materials for paving purposes.

The argument that a certain definite amount of paraffine scale found by analysis indicates at least the presence of an undesirable amount of oils of the paraffine series has also been shown to be fallacious, both by the satisfactory results obtained by the use of up to 30% of paraffine residuums as fluxes in many old pavements which have given excellent service and further, because practical experience has shown that in many cases asphalt cements made with paraffine residuums are superior to those made with semi-asphaltic residuums. This is well illustrated in Table VI., where an asphalt cement prepared from Texas asphalt using a high paraffine residuum is much better than one prepared from the same asphalt with a low paraffine residuum.

The modification of the Holde method for the determination of paraffine scale in bituminous road compounds now in general use and as recommended by the Bituminous Committee of the American Society of Civil Engineers when worked by different operators does not give concordant results, even though the operators endeavor to faithfully follow the instructions in every minute detail. Any one operator by making slight modifications which would not, however, constitute a departure from the prescribed method will obtain varying results. The variations in both of these cases will frequently exceed 100%.

When we consider the uncertainty of the value of this test and the difficulty of obtaining concordant results with the method in use, it is very evident that no one is justified in condemning a road material because it shows an amount of scale paraffine in excess of an arbitrary limit which has been fixed at a certain point without regard to either theory or practice.

THE DEFINITION OF ROCK IN SEWER SPECIFICations recently adopted by the Board of Local improvements of Chicago is as follows:

Wherever the word "rock" occurs in these specifications it shall be interpreted to mean any material geologically in place and of a hardness when first exposed of three or greater in the scale of mineral hardness, which corresponds to the hardness of the transparent variety of calcite. Other materials shall not be classed as rock, although it may be more economical to remove the same by blasting.

Further clauses relating to rock are as follows:

No claim for an amount of money beyond the contract price of the work will be entertained or allowed on account of the character of the ground in which the trench or other excavations are made, except for the rock cutting heretofore specified.

An additional interesting feature of the specifications, relating to protection against water, is briefly expressed in the following words:

Where the excavation to its entire depth is in wet sand the contractor shall install a pumping system connected with well points so as to effectually drain the sand.

Serious Injury to a Reinforced-Concrete Building by Electrolysis.

By HAROLD P. BROWN,* M. Am. Electro-Chem. Soc.

Engineers are familiar with the corrosion of buried water pipes by electric-railway current returning to the power house from poorly bonded track and they generally look for the area of injury near the power house or sub-station where the current leaves the pipes on its way to the negative terminal of the dynamo. The metal surface of the pipes at the point of departure is covered with a layer of iron rust beneath which is found characteristic pitting. While the cause and cure of this trouble are now well understood, few have imagined that electrolysis could possibly injure a building of modern reinforced concrete. On the contrary, many papers have been written to prove how thorough a protection is given to steel by properly applied concrete.

FIG. 1. VIEW OF CEILING SHOWING EXPOSURE OF RODS IN A BEAM.

It is also well known that not long ago electrolysis destroyed the lower ends of the foundation bolts of a number of elevated railway columns where the current was carried on the structure. It was accordingly feared that the same might happen to buildings of structural steel. But none thought it possible that electricity could leak to steel deeply buried in beams and girders, and split the concrete apart. Yet this is exactly what has occurred in thousands of feet of concrete, and engineers who design concrete structures must take new precautions to secure safety and permanence.

During the past few years there have been persistent rumors of injury of this kind to large and expensive concrete structures, and these rumors have led to various laboratory experiments in this line which have been reported at great length.† Letters of inquiry have also been sent out asking full particulars concerning the behavior of reinforced concrete, but for obvious reasons the architects, designing engineers and owners of damaged buildings have not cared to reply, and it has therefore been wrongly inferred that no cases of failure have been caused by electrolysis.

A few weeks ago the writer was asked by the president of a prominent electric railway to examine a large reinforced-concrete packing house not far from New York, where it was claimed that the railway return current had caused great injury. It was stated that a dozen or more prominent experts had been called in by the owners of the building and had advised a suit against the railway whose power house is located about 300 ft. to the north. The building was completed in October, 1906, and comprises a number of connecting structures of three, four and five stories and basement, with about 300,000 sq. ft. of floor space. In the summer of 1907 horizontal cracks appeared on the lower surface of various beams and girders parallel with the reinforcing steel, and these have steadily grown worse.

Permission was readily given to visit the building and to photograph the damaged portions. There could be no question about the amount and serious nature of the damage, for over 3,000 lin. ft. of girders and beams showed wide cracks 2 ins. deep, reaching from their lower surfaces to the round steel rods of the reinforcement. Seven columns had deep vertical cracks in line with the rods, some of these penetrating to a depth of 4 ins. and forcing off large pieces of concrete. In many places the outer surfaces of the rods were entirely exposed, and were seen to be covered with a layer of tough iron oxide (hydrated oxide of iron), from ⅛ to ¼-in. thick. This oxide had evidently forced the concrete apart and caused the damage. Figs. 1, 2 and 3 show characteristic cracks and exposed rods in beams and girders of the cooling rooms on the first story. In every case the most serious injury is underneath rooms cooled by refrigerating pipes which of course keep the floor and its supports constantly damp. But in this area there is not a crack in any floor slab, since its reinforcing steel is not electrically connected with that in the girders.

The writer agreed to make a thorough electrical examination of the building for the railway, on condition that the electrician representing the owners should verify each observation and measurement, and full and exact details be dictated to a stenographer at the time when readings of the instruments were made. In this way no controversy could arise over the recorded facts, although each party might have his own interpretation.

The electrician for the packing company had been at work for six or seven weeks and had run test wires from a central point to the reinforcing rods in various parts of the building. He was firmly convinced that the railway current had caused the trouble, and willingly set out to prove his views. Double tracks of the electric railway pass in front of the building and a single track leads on one side of it to the adjoining power house of the railway company at the rear. With this location it did look as though there might be some basis for the accusation against the railway current, provided the injury was shown to be caused by current flowing to the north on the cellar girders, or flowing downward on the cellar columns on its way to the power house. Such current, however, could not be found.

The electrician showed that the city water pipes across the street from the building indicated occasionally a pressure of about 6½ volts positive to the rails on that street, which was bad for the pipe. This was due to a broken connection on the railway return circuit, which has since been corrected. The city pipe was about 4¾ volts positive to a local water pipe from the building, crossing the street to the packing-house stables. The local pipe was 1¼-ins. in diameter, and where it entered the south basement wall of the building, there was clear evidence that it brought in railway current on its way towards the power house. This pipe had an unbroken length of 20 ft. and was insulated from the basement ceiling by wooden wedges thrust between it and the clamps supporting it. A Weston laboratory-type voltmeter with a swing of ⅞ in. to a milli-volt, showed a maximum drop of 1½ milli-volts in the 20 ft., with current less than 0.8 amp. The same instrument showed that this pipe was 3¾ milli-volts positive to the reinforcing steel, which is far too small a pressure to do any damage, as is shown by the quotation from Mr. O. P. Watts below.

Another instrument indicated a drop of 110 volts between the positive wire of the electric light circuit and this pipe. This showed a bad ground on the negative side of the circuit, and here was really the key to an explanation of all the trouble.

The pipe turned upward from the 20 ft. length through the concrete floors to a tank on the roof, but no electric current upward could be found in it above the first floor. The railway current of less than one ampere evidently passed into the damp concrete floor and into the adjoining iron work of a four-story smoke house and could not be found again. There are no city water pipes in the building, and this local water pipe was the only connection found with the railway circuit. As above stated, the cellar columns showed no injury and no sign of a downward current, and there was no northward flow on the cellar girders, as would be the case if the railway current were doing the damage. The clue of the grounded lighting circuit was then followed.

In the ceiling of the hide cellar, a partial ground was found upon the local electric light circuit near the south wall, with a potential varying from 10 to 20 volts and a current direction to the south and east. Here a few beams and girders were badly cracked. As shown in Fig. 4, some of the stirrups connected with the reinforcement had pushed off large scales of solid concrete. These stirrups were originally 1 in. wide and ⅛ in. thick. The oxide over them, which was removed for analysis, was from 3/16 to ¼ in. thick, while the metal of the stirrups showed fully 1/16 in. of uncorroded steel. The thickening of the stirrup to the extent of an additional 1⅛-in. of rust, under the influence of the current evidently caused the cracks. This thickening has occurred only where the concrete is damp and where the steel has an electrical potential positive to the ground.

Fig. 5 shows the detail of the reinforcement of the beams and girders, made up of plain round bars, some continuing across the lower edge of the beams and others bending upward to reach the top of the beams at their ends. There are frequent U-shaped stirrups of 1 × ⅛ in. steel and ties of ¼ in. wire. Similar ties join the horizontal bars to the vertical rods of the columns. Two or more cast-iron sockets are placed on each beam and girder and held by bolts which clamp the rods together. There are distributed through the building about 3,600 of these sockets which reach the lower surface of the concrete and are

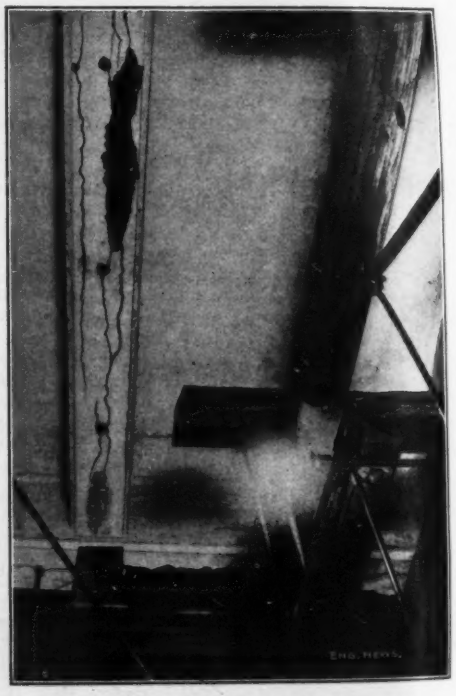


Fig. 2. Cracks in Lower Part of a Girder.

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†See p. 687 of this issue and the foot-note to the article on that page.

tapped for ¾-in. bolts so as to be available for supporting the water and steam pipes and the overhead tramways, etc., as shown in Fig. 2. About 600 of them are used to hold the steel conduits carrying the electric wires.

It was the use of these sockets for the latter purpose which led to most if not all of the injury to the building. A two-wire direct-current electric-lighting and power system is used at 120 volts pressure, with triple-braided rubber-covered wire of the best quality placed in japanned steel conduits. These conduits, of course, have openings at every switch, outlet and fixture, and through these openings the water of condensation from the steam and vapor in the building comes into contact with the insulated wire and with any bare portions where connections are made. There is more or less acid present all over the building resulting from the rendering and other processes carried on, so that the condensed moisture is a very good conductor, compared with pure water, and so is the concrete where saturated with it.

The practical result in many of the rooms is that at various points individual positive and negative wires are immersed in a conducting fluid which is in contact with the metal of the conduit and therefore in contact with the metal reinforcement of the building, through the above mentioned sockets. If the condensed vapors immersed both positive and negative conductors where exposed, a more or less complete short circuit would have resulted, but probably this is not the usual circumstance.

Usually there resulted a local leakage from the electric circuit which may best be illustrated by picturing the moisture of condensation and the concrete as representing the electrolytic fluid in an electro-plating bath. The positive conductor of the lighting circuit would then represent the anode of the bath from which the current flows and the negative conductor corresponds to the cathode to which the current goes. A metal plate introduced into the fluid of a plating bath midway between the two electrodes would show a negative potential of practically half the voltage when compared with the anode, and an equal positive potential when compared with the cathode. The metal plate may represent the conduit in this case and it is in metallic contact with the steel reinforcement of the concrete. If the plate is nearer the anode the electric pressure between it and the anode will diminish, while the pressure between it and the cathode will correspondingly increase. In this building, with the moisture in the conduit openings and in the concrete serving as a conducting fluid, the sum of the two potentials, positive wire to conduit and negative wire to conduit, always amounts to the potential between the positive and negative wires, less some 10 volts. This difference evidently represents the loss due to the chemical decomposition and to overcoming with resistance of the leakage path. The current passes from the positive copper wire at some outlet through the condensed vapor to the iron c[illegible] the reinforcing steel [illegible] paint. [illegible] finally [illegible] Tockolith and one coat R. I. W. No. 110. Bare iron alternating current. Salt water

through the concrete to the steel of another member and thence along the conduit to some opening where the condensed vapor has grounded the negative wire.

The behavior of a liquid conductor has been well described in a recent article by Mr. Oliver P. Watts in the following paragraph:

> In a metallic wire, the resistance of which is known, the current may be calculated by the application of Ohm's law. This is not so for electrolytes when "direct current" is used, except for a few combinations of special electrodes with a particular electrolyte. If a gradually increasing electro-motive force is applied to the ends of a wire and simultaneous readings of the current and pressure are made, the current increases in the same ratio as the E. M. F. When an electrolytic conductor with electrodes of platinum, carbon, or some other material insoluble in the particular electrolyte chosen, is substituted for the wire, it is found that for small values of pressure no permanent current flows. The E. M. F. must exceed a certain minimum value before a permanent current is obtained.

The author goes on to show that with a salt solution this minimum is about one volt and with a certain acid solution about 1½ volts. Therefore to cause any damage in this case a greater pressure than 1 or 1½ volts must be shown by a railway current entering the building on one conductor, passing through an electrolytic path to reach a second conductor.

Returning to the consideration of the local electrical circuits in the building, which has many fire walls of brick, it is evident that there can be a leakage from the positive wire to the reinforcement through the concrete to the reinforcement at another point and to the negative wire without operating the ground "detector" in the distant engine room. Indeed there might be a dangerous leakage through the "detector" unseen. This local leakage is small every morning when work is started and grows steadily larger during the day as more and more moisture condenses in the conduit openings. The concrete is cracked in various parts of the building wherever the concrete is damp and the steel reinforcement shows a positive potential of more than 5 volts to the ground. It is not cracked elsewhere even when frequently flooded with salt water.

A thorough examination of the building shows 32 girders with 503 lin. ft. of crack[illegible]

28 large beams with 502 ft.	Salt water	198 days	100.0	0.007	30.1
with 1,991 ft.	Salt water	198 days	40.0	0.003	18.1
Girder [illegible]	Salt water	198 days	39.2	0.004	19.0
[illegible]	Salt water	198 days	104.0	0.001	4.8
[illegible]	Salt water	41 days	31.0	0.005	4.9
[illegible]	Salt water	124 days	107.0	0.000	0.0
[illegible]	Salt water	198 days	40.2	0.445	2,115.0
			(Two blocks in series)		

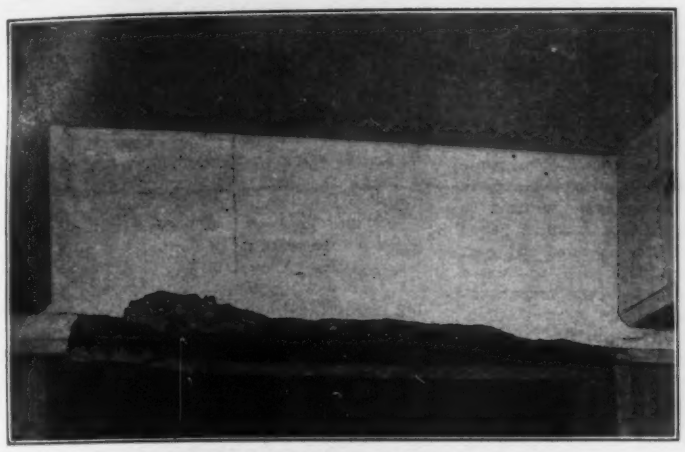


FIG. 3. EXPOSED RODS IN ANOTHER GIRDER.

FIG. 4. CONCRETE FORCED OFF AT STIRRUPS OF BEAM.

great strength. The amount of chlorine present in the concrete was but 0.38%. An analysis of the decomposed iron showed chlorine to the extent of only 0.02%, so the failure cannot be laid to the use of salt. The water similar to that used in the concrete was found to contain 4.43 grains of chlorine per gallon with traces of sulphates, but not to an important degree. It is therefore evident that the concrete itself did not contain any material which caused the cracks.

A few days after the preliminary examination, the writer, in the presence of the owners and the electrician of the packing house met the engineer who had designed and supplied the concrete reinforcement of the building. This gentleman stated his belief that the building had been ruined, that the publication of its condition would injure the financial standing of the owners and cause cancellation of the insurance, that he was certain that the railway current had caused the damage and that the railway company must either pay for it or stand a suit!

It was therefore necessary to make a demonstration of the electrical facts in the case, in the presence of these witnesses. One volt-meter was placed in circuit with a wire leading from a city hydrant some distance away and a wire leading to the negative cable connected to the track circuits of the electric railway. This voltmeter indicated the presence of the electric-railway potential with [illegible] bar.

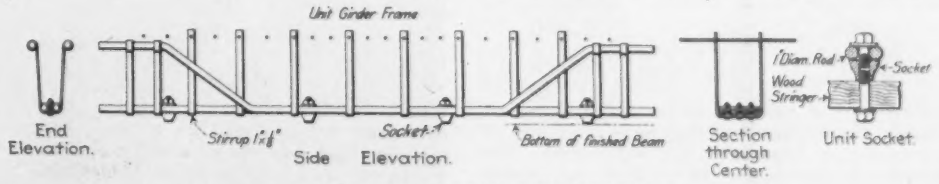


FIG. 5. DETAILS OF BEAM REINFORCEMENT.

teristic variations.

[illegible] corroded.
placed [illegible]cked; iron corroded.
Block cracked; iron corroded.
Rusty water at top of block in 16 days. No further evidence of action.
Block cracked; iron corroded.
Block cracked; iron corroded.
No evidence of corrosion.
No action for four months. Block finally cracked; iron corroded.
No evidence of corrosion.
Block cracked; iron corroded.
No evidence of corrosion.
No evidence of corrosion.

This was done and the needle of the first instrument fell to zero, while the needle of the second instrument did not waver from its former reading. The railway current was re-established and the local dynamos were then shut down. The needle of the second instrument connected with the steel reinforcement of the building returned to zero, while the first instrument was unaffected. This demonstration convinced the owners of the building that the railway current was not to blame.

Early in March of this year, a number of concrete blocks were made up measuring about

Fig. 6. Cracks in a Column Along Reinforcement.

5 × 4⅛ × 9⅛ ins. Each block contained two 1-in. rods of the same kind of steel as had been used in the reinforcement of the building, placed in the center line ¾ in. apart. Two of these blocks were put in circuit about March 28 between the local water pipe above referred to where it entered the south wall of basement, and a damp cellar pillar near the north wall of the building, and thus were submitted to the action of the railway return current at the pressure previously reported. These blocks have not been cracked, although they are still in circuit. Other blocks were connected between the reinforcing rods and a wire leading to the negative bus bar of the railway power house. These were submitted to a pressure of three volts for many weeks but have not been impaired.

A similar block was placed in the engine room so that it received the same leakage pressure as was shown to exist on some of the reinforced steel of the building. This was connected on the afternoon of April 10. Two days later a crack was found around the rod which had the positive connection. By April 19 this crack had widened to 1/16 in. from end to end of the block ers ov[illegible] about two inches of solid concrete. There the railway whose powe[illegible]e negative rod. This 300 ft. to the north. The buil[illegible] building pleted in October, 1906, and comprises a number of connecting structures of three, four and five stories and basement, with about 300,000 sq. ft. of floor space. In the summer of 1907 horizontal cracks appeared on the lower surface of various beams and girders parallel with the re-

*Consulting Engineer, 120 Liberty St., N. Y. City.
†See p. 687 of this issue and the foot-note to the article on that page.

heavy current at 110 volts was passed through it from an iron bar immersed in water. This was heated by the current to nearly boiling temperature but no cracks have developed though many weeks have passed.

These demonstrations led the owners of the building to retain the writer to correct the electrical conditions of the reinforcing steel and to repair the damaged concrete. This report has been written with their full approval, though their address is withheld until the restoration is completed.

It must be admitted that the designing engineer still holds the opinion that the railway current is to blame and that the building is injured beyond repair. In order to find whether the damage had yet reached a dangerous stage it was decided to consult a very prominent engineer with many years' experience in reinforced-concrete designing and construction. The following is a portion of his report:

Effect of Damage on Strength of Structure.

"The beams and girders are reinforced by the old Hennebique method of plain round bars, some of them continuing straight along the lower edge of the beams and others being bent upward to reach the top of the beams at their ends. (See Fig. 5.) The web members are of light flat bar, apparently placed without reference to shear stresses. They are unattached to the main bars and are employed only as binders in the beam. They can, therefore, transmit only web stresses through their bond with the concrete and through the adhesion of the concrete to the main bars.

No anchorage is provided in the concrete at the ends of the main bars. No reverse reinforcement is provided such as would be the case if the main bars were long enough to extend into the next beam or separate bars were placed at the top of beams tying the ends of adjacent beams together and forming a system of "continuous beam," in which the cantilever principle is combined.

The structure of the beams, as above mentioned, is wasteful in steel and contrary to the best engineering practice, but it has proved satisfactory in use. When we discover, as in the present case, that an important link in the chain—the adhesion of the concrete to the steel—is being destroyed, we find that this system of reinforcement is about as bad as it could be. We are forced to rely upon the remaining bond at the ends of the beams for the integrity of the structure.

FIG. 7. TYPICAL BEAMS AFFECTED BY THE ELECTROLYTIC ACTION.

Experiments have demonstrated that an adhesion of 250 lbs. per sq. in. of bar surface is conservative, thus: a ⅞-in. mild steel bar may be embedded in concrete to a depth of 2 ft., and will [illegible] equal to its elastic limit to break [illegible] clamps suppl[illegible] voltmeter with a swing[illegible] is based upon 24 diam- showed a maximum drop of 1½ mi[illegible]:2:4 rock con- 20 ft., with current less than 0.8 amp. The same instrument showed that this pipe was 3¾ millivolts positive to the reinforcing steel, which is far too small a pressure to do any damage, as is of the cracks being parallel with the reinforcing members at the lower edge of the beams. A few minutes vertical and a few diagonal cracks were also found, but these are not at all unusual and do not necessarily indicate weakness.

The beams having the deep lengthwise cracks appear to be dangerously impaired for strength on account of the complete separation of the concrete from the steel for some distance each way from the middle of the beam and the consequent destruction of the bond between them. I found, however, that the ends of the beams were intact where they join the columns or walls, and that the concrete had apparently not separated from the bars at the ends of the beams, consequently the bars retained their anchorage in the ends of the concrete beams.

To demonstrate that this was the case, the beams over the railway track and loading platform, which were the worst beams in the building in appearance (shown in Fig. 7), were selected for a deflection test. They varied from 19 to 23 ft. in span. Those selected were the second and fourth from the west wall and were about 20 to 21 ft. span. The beams were 12 ins. in width by 18½ ins. deep below slab, 5 ft. 3 ins. c. to c. The load was removed from both these beams before testing. Deflection testing apparatus was applied to them and adjusted; then the floor was loaded with large pails of lard piled five high from the west wall to the sixth beam, excepting along north wall where they were three high, making about 250 lbs. to the sq. ft., with a deflection in the middle of the second beam from the west wall of 0.055 in. The fourth beam from the west wall showed a deflection of 0.05 in. This deflection was regular, it increased regularly as the load was applied and showed conclusively that the beams are not yet seriously weakened in their load carrying capacity. However, if the present electrical conditions are allowed to continue, the bond between the bars at the ends of the beams will be destroyed both on the horizontal bottom members and on the bars which extend diagonally upward to the top of the beams at their ends. When this bond is impaired the beam will no longer sustain its load and the destruction of the building will be inevitable."

Conclusions.

When the work is completed the writer will be glad to report the details of the necessary correction of the electrical troubles and to describe the methods of restoring the injured concrete. These have already proved to be effective as far as applied. Meanwhile the following suggestions are offered in regard to electrical circuits in damp reinforced concrete buildings:

(1) Do not depend for insulation upon even the best rubber covered wire nor upon japanned conduits in rooms subjected to fumes and vapors.

(2) Do not permit the grounding of the intermediate wire in the three-wire systems.

[illegible]-wire system do not place the the rods togeth[illegible] present when actually the building about 3,600 of these [illegible] reach the lower surface of the concrete and are

(4) Do not permit any grounding of the secondary circuit of a transformer.

(5 Bind together electrically all the reinforcing steel of each bent, and bring from it a suitable wire leading to the surface of the concrete to use for testing and other purposes if necessary.

(6) In the vicinity of electric power houses or sub-stations use wooden pipe for gas or water service pipes from the street mains. Use insulating tubes around the gas, water or steam pipes where they pass through concrete floors or walls.

(7) Make frequent tests for stray currents between reinforcing steel and ground, using low-reading instruments. Never permit any pipe or reinforcing rod to show a potential positive to the earth or to the nearest negative conductor.

It cannot be denied that this is a complicated problem, requiring careful study of many important factors which may vary in different localities.

Further Experiments on the Electrolytic Disintegration of Reinforced Concrete.*

A line of experiments on the corrosion of iron in reinforced concrete and on the disintegration of the concrete itself subject to electric current which have been carried on in the Electrical Engineering Laboratory of the University of Washington at Pullman, beginning in 1907, are now described in a paper by Messrs. C. E. Magnusson and G. H. Smith, printed in the Proceedings of the American Institute of Electrical Engineers for May. A brief review of these experiments is interesting in view of one questionable conclusion which the authors have made and on account of certain methods of protection which were given a preliminary trial.

The Portland cement used in the concrete for these tests was a local brand, the "Washington," considered a good quality and much used about the Puget Sound. The average figures from one series of tests on tensile strength gave 108 lbs. per sq. in. after 24 hours' set, 499 lbs. after seven days, and 717 lbs. for 28 days.

At first experiments were undertaken to corroborate the rupture of cylindrical specimens with a centrally imbedded bar of iron. There were the usual and expected affirmative results. Next determinations were made of the electrical resistance of concrete blocks, wet and dry. For these tests, eight sets of 24 cubes each were made; 12 from each set were of neat cement and 12 were of mortar, presumably a 3:1 mixture. There were three 3-in., six 2-in. and three 1-in. cubes to each set. Uniformity was sought after and consistency of mixture was tested with a Vicat needle (for a scale reading of 10). The cubes were kept moist for 20 days and then submerged for ten days more. Sets 1, 2, 3, 4, 7 and 8 were placed in a steam-heated room and Sets 5 and 6 were put on the radiator in the same room. The cubes were dried in this manner for 40 days. The 2-in. cubes of Sets 5 and 6 showed losses of about 9 and 13.5% for the cement and mortar cubes, respectively. The various other sets showed slightly less loss.

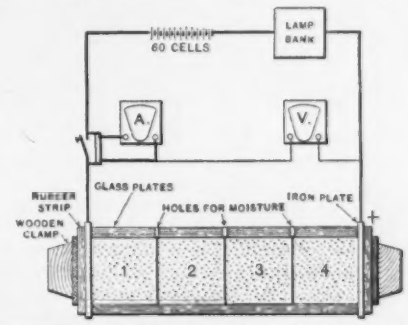
*Various studies into the disintegration of reinforced concrete and the corrosion of imbedded iron have been noted in Eng. News, March 21, 1907, Dec. 24, 1908, April 29, 1909.

TABLE I.—RESISTANCE OF NEAT CEMENT AND MORTAR BLOCKS.

	Specific Resistance.
Dry neat cement	12.7×10^6 ohms
Dry mortar	10.6×10^6 "
Wetted cement (Cedar River water)	8,700 ohms
Wetted cement (Lake Washington water)	7,000 "
Wetted cement (Fifth normal NaCl solution)	5,500 "
Wetted cement (Half normal NaCl solution)	3,850 "
Wetted mortar (Cedar River water)	7,400 "
Wetted mortar (Lake Washington water)	6,700 "
Wetted mortar (Fifth normal NaCl solution)	4,500 "
Wetted mortar (Half normal NaCl solution)	2,900 "
	20° C. 30° C.
Cedar River water	20,100 ohms 15,600 ohms
Lake Washington water	15,400 " 12,100 "
Fifth normal NaCl solution	54.4 " 45.5 "
Half normal NaCl solution	24.2 " 19.6 "

The electrical resistances were measured by galvanometer methods, the cubes being pressed between copper plates. Set 5 (dry) showed fairly uniform results giving specific resistance (between faces of a centimeter cube) of 1,270 and 1,060 megohms for neat cement and mortar specimens, respectively. Several sets were immersed in various solutions for two weeks and then tested for resistance with the results shown in Table I.

These results seemed to indicate that very dry concrete is practically an insulator and that wet concrete is a fairly good conductor, comparatively speaking, the resistance wet being only from 1/140,000 to 1/400,000 that of the dry figure, depending on the conductivity of the solution. This is quite in accordance with the results reported at various times by Prof. E. E. F. Creighton in connection with his papers on lightning arresters.



Arrangements for Experimental Electrolysis of Concrete Blocks, University of Washington.

To secure data on the effect of current alone on the strength of concrete, experiments were made with sets of four cubes in series, as shown in the accompanying figure. At each end was a plate of iron with a copper contact wire soldered to it. Glass plates were placed outside of the iron, for insulation, and the series put under pressure to secure better contact between the iron and concrete and between each two cubes. Glass plates were cut so as to fit the sides of the cubes, and were held in place by steel clips. The top plate was drilled with several holes, as shown in the accompanying figure, and the salt solution was continually supplied to keep the cubes wet. A storage battery was connected in series with the four cubes and current kept on continuously for 25 days for one set and 30 days for the second set.

The iron anode corroded and the two cubes nearest this end became covered with iron oxide. The cubes were tested for strength in compression with the result that little or no difference was found between the four cubes of each test compared with themselves or with two check cubes which were not subjected to the current. These findings do not agree with the results of other experimenters who find a certain amount of disintegration of the concrete under somewhat similar physical and electrical conditions due (perhaps indirectly) to the passage of current and not to mechanical pressure developed at the electrode surfaces by the products of corrosion. Certain masking actions can be recognized in the Washington experiments, as just described, to account for disagreement. It is seen that the cubes were immersed and enclosed in a glass box, which must necessarily have been somewhat loose-fitting, no matter how carefully the work was done. As a consequence, there must have been a layer of electrolyte all over the outside of the line of blocks, and, indeed, the authors remark in their paper that they hope to secure "a minimum by-path of the current outside of the cubes." A study of the data presented on these tests shows that the resistance of the arrangement shown in the accompanying figure is about half what would be expected from the four cubes in series with the values given in the accompanying table. Closer computation shows that something over 50% of the current must have gone through the liquid films around the blocks, which reduces the current through the concrete itself to such a low density that in the short space of time covered by the tests they fail to show any diminution of strength. The iron anode corroded and the iron passing into solution was converted into oxide. This would travel with the current, by cataphoric action, and the authors show that it was deposited on the outside of Cubes 3 and 4 nearest. Had the current flowed through the cement blocks, for the most part there would have been comparatively little staining on the outside, but the iron oxide would have penetrated appreciably into the pores.

The authors of the paper leave such investigations into causes and underlying phenomena to investigate certain proposed remedies. It is interesting to note wherein such proposed remedies have failed, for in fact none of the means within reach gave practical benefit. In order to study waterproofed concrete, a set of blocks, with an imbedded central electrode, was made up with one part of soap to 100 parts of water and one part of alum to 100 parts of cement. This was ineffective, as shown in Table II. Zinc coatings were tried on the imbedded iron with similar results.

Aluminum rods were used, bearing in mind the peculiar properties of aluminum electrodes, as in the electrolytic lightning arrester, by which a high resistance layer is quickly built up about

TABLE II.—ELECTROLYTE DESTRUCTION OF "PROTECTED" REINFORCED-CONCRETE SPECIMENS.

	Electrolyte.	Time in circuit.	Volts, average.	Amperes average.	Amperes hr. approximate.	Results.
(1) Bare iron	Fresh water	26 days	92.0	0.071	44.3	Cracked in 29 hrs. Finally split into four pieces and iron bar deeply corroded.
(2) Bare iron	Salt water	35 days	8.0	0.04	33.6	Cracked in 7 days. Finally split into two pieces. Iron corroded.
(3) Bare iron	Salt water	5 days	29.0	0.25	30.0	Block cracked; iron corroded.
(4) Bare iron concrete mixed with soap and alum	Salt water	21 days	30.2	0.128	64.5	Block cracked; iron corroded.
(5) Red lead in linseed oil	Salt water	47 days	30.0	0.076	85.7	Block cracked; iron corroded; paint decomposed.
(6) Red lead in linseed oil	Salt water	7 days	31.0	0.145	24.4	Cracked down side and across top. Bar slightly corroded; paint film decomposed.
(7) Graphite paint	Salt water	9 days	31.0	0.205	44.3	Cracked across top and down side; iron deeply corroded.
(9) Zinc coated iron bar	Salt water	4¼ hrs.	101.0	1.65	7.4	Block cracked; chlorine and steam given off next to bar.
(10) One coat of aluminum in amyl acetate	Fresh water	38 days	42.0	0.123	112.0	Block cracked; iron deeply corroded.
(11) Two coats of aluminum in amyl acetate	Sea water	14 days	43.5	0.040	13.4	Block cracked; iron corroded.
(12) Three coats of aluminum in amyl acetate	Fresh water	26 days	92.0	0.019	11.9	Block cracked; iron corroded.
(13) Three coats of aluminum in amyl acetate	Sea water	37 days	103.7	0.019	16.9	Block cracked; iron corroded.
(14) Three coats of aluminum in Florette varnish	Sea water	197 days	100.0	0.001	4.7	Rusty water at top of block in 16 days. No further evidence of action.
(15) One coat Florette varnish	Salt water	179 days	42.0	0.007	30.1	Block cracked; iron corroded.
(16) Two coats marine Tockolith	Salt water	73 days	100.0	0.007	12.3	Block cracked; iron corroded.
(17) Two coats P. & B. paint	Salt water	252 days	40.0	0.008	18.1	No evidence of corrosion.
(18) Two coats P. & B. paint	Salt water	198 days	39.2	0.004	19.0	No action for four months. Block finally cracked; iron corroded.
(19) Two coats asphalt paint, T. C. U. Co	Salt water	198 days	104.0	0.001	4.8	No evidence of corrosion.
(21) Two coats R. I. W. No. 110 paint	Salt water	41 days	31.0	0.005	4.9	Block cracked; iron corroded.
(22) Two coats Tockolith and one coat R. I. W. No. 110	Salt water	124 days	107.0	0.000	0.0	No evidence of corrosion.
(24) Bare iron alternating current	Salt water	198 days	40.2 (Two blocks in series)	0.445	2,115.0	No evidence of corrosion.

the aluminum electrode to limit the flow of current. With 36 volts the current was cut from 0.18 amps. to 0.01 amp. in a few minutes and kept at that low value for 67 days, though the voltage across the circuit was increased to 110 volts. There was no effect on the concrete. As it was not possible to plate the iron with aluminum, resort was had to using a few coats of aluminum paint (amyl-acetate vehicle). There were indications of the same limiting action, though slightly inferior to that with aluminum bar. The time required for the destruction of the blocks was increased where the imbedded iron was painted with this aluminum paint, but the final results were the same. Trials were made with aluminum flakes in varnish and with various insulating paints and varnishes, all with similar results, as shown in Table II.

The Stone Crushing Plant of the Acton Rock Co., Los Angeles, Cal.

The Acton Rock Co. has now under construction at its quarry near Los Angeles, Cal., a rock crushing plant of very compact design. While none of the machinery is of exceptional size nor specially designed, the arrangement of the various parts is so well adapted to the rapid production of crushed stone that its details are worthy of description.

The quarry from which the stone is taken is located about a half-mile from the edge of a steep bluff, and in order to reduce the conveying machinery so far as possible the crushing plant has been placed at the edge of this bluff, taking the rock from the quarry on a level some 150 ft. above the lower end of the plant where the crushed rock is stored. Electrical power is used in all operations, with the exception of the steam shovels for the handling of the rock at the quarry, but the location of the crushing house is such that gravity materially aids all the mechanical operations there.

At the quarry the stone lies very close to the surface so no stripping is necessary. Compressed-air drills, with motor-driven compressors, are used in preparing the rock for the blasting and steam shovels for loading it on the cars, which are hauled by an electric locomotive to the crushing plant some 3,000 ft. away. The accompanying Fig. 1 shows a view of the plant during construction, and Fig. 2 shows the details of the plant proper. As will be seen, it is located on the sheer edge of the bluff and is founded on steps cut into the rock with concrete retaining walls on the sides of the steps. The upper works of the plant are all of timber construction.

Rock coming from the quarry is dumped first down a timber incline, lined with steel T-rails, into the initial crusher, which is of the "12-K" type of the Gates gyratory crusher. This has an opening of 27 × 84 ins., and delivers the stone, at a minimum size of 6 ins., from a single discharge opening located opposite the driving pulley. The stone from this crusher enters a 48-in. × 14-ft. revolving screen, which is provided with a dust jacket delivering to a 12-in. conveyor and thence to a dust pile outside the building. The rejections from the screen are delivered to one or both of two "5-K" type of the Gates gyratory crusher, which have an opening of 10 × 38 ins. each, and which deliver stone down to sizes of 1¾ ins. From these crushers the stone passes directly to a 24-in. conveyor which carries it to the final screens. This conveyor also passes under the delivery chute of the 48-in. × 14-ft. screen, taking therefrom all stone of the proper size. The 24-in. conveyor runs about 90 ft. to two 48-in. × 24-ft. revolving screens or through the final screens direct to a main 24-in. conveyor, which drops it in the storage bin.

The No. 12 breaker, the 48-in. × 14-ft. screen and the 12-in. dust conveyor are driven by a 175-HP., three-phase, 60-cycle induction motor.

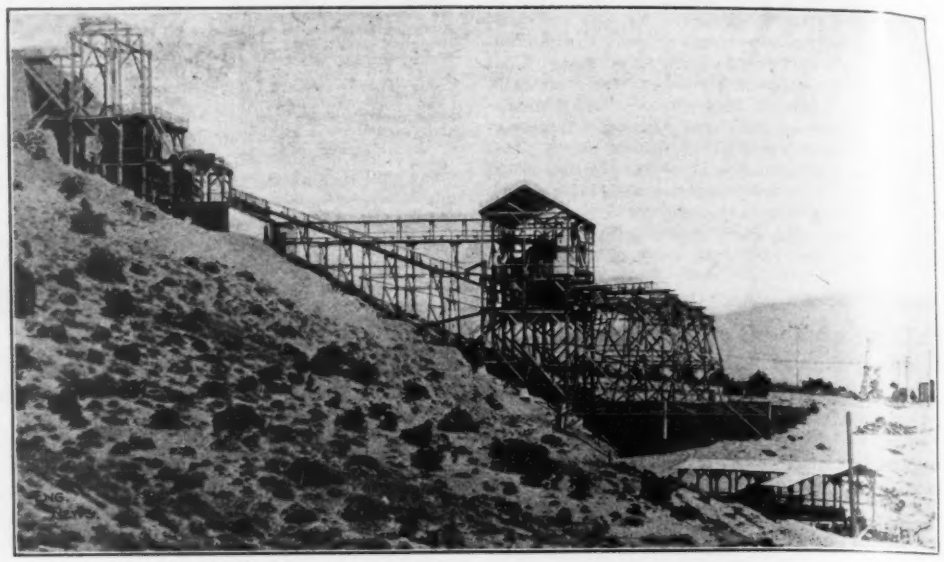


FIG. 1. VIEW OF ACTON ROCK CRUSHING CO.'S PLANT.

One of the No. 5 breakers is driven by a 30-HP. motor, and the other No. 5, together with the No. 2, and the 12-in. inclined conveyor, are driven by a 40-HP. motor, all having the same characteristics. These motors are all housed in dust-proof rooms.

The bin is formed by an earth embankment and is about 77 × 178 ft. extreme inside dimensions. The inner slope is at an angle of 45°, as shown, and is completely paved with an 8-in. layer of concrete. Running under the entire length of the bin is a heavily timbered tunnel 13 × 14 ft. in section and provided with 24-in. openings spaced 8 ft. c. to c. These openings are controlled by gates operated from outside the tunnel. The track arrangement is such that four cars can be placed in the tunnel at one time and all loaded simultaneously. The capacity of the bin is about 9,000 cu. yds., and it is estimated that the plant will turn out between 1,500 and 2,000 cu. yds. a day. The product is used principally for ballast and somewhat for commercial sale around Los Angeles.

The plant was designed by the Young Construction Co. of Los Angeles, and the machinery was furnished by the Allis-Chalmers Co., of Milwaukee, Wis.

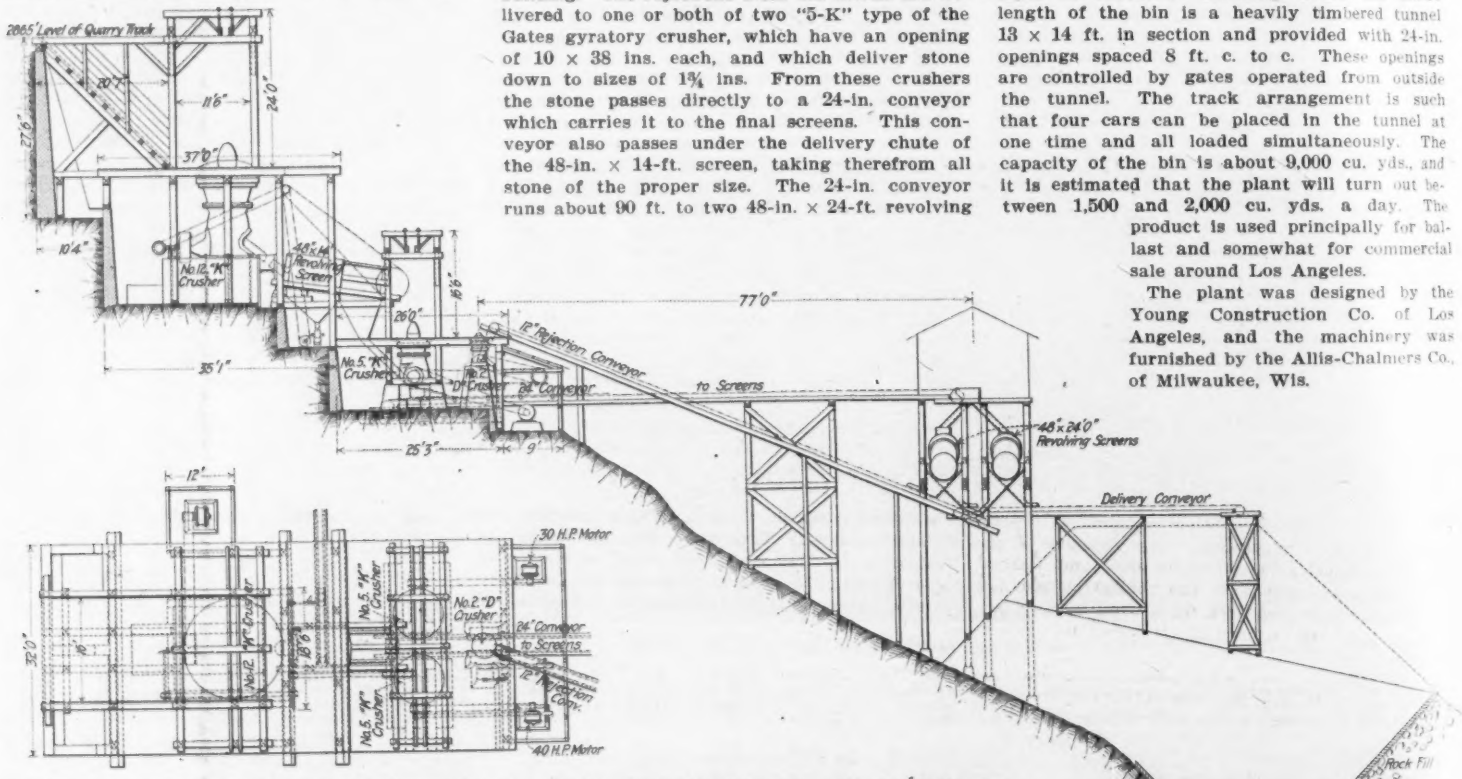


FIG. 2. LAYOUT OF THE ROCK CRUSHING PLANT OF THE ACTON ROCK CO., LOS ANGELES, CAL.

Hypochlorite Disinfection of Indoor Swimming Tank, at Northwestern University.

W. LEE LEWIS.*

The possibilities of an indoor swimming tank becoming unhygienic are apparent when one considers the extensive use of a relatively small body of water, and the absence of sunlight, fresh air, sedimentation and the various forces operative in the self-purification of outdoor waters. Furthermore, the coughing, spitting and snorting of the average swimmer is most favorable to contamination of the water with the disease germs typical of the respiratory tract, as those of tonsilitis, pneumonia, tuberculosis, common colds and sore throat. Intermittent users of these tanks often attribute mild sore throats or coughs to the exposure, whereas they more probably result from direct infection. Burrage[1] notes such mild epidemics at the Purdue Gymnasium, and while such observations are not conclusive, I have noted a prevalence during the past winter of la grippe, colds, sore throat, and some cases of pneumonia, restricted rather strikingly to the users of the swimming tank in Northwestern Gymnasium.

It is now generally conceded that well persons may spread typhoid fever through the persistence, after recovery, of the germs of this disease in the body. This fact, together with the repeated demonstration of B. coli in the waters of swimming tanks[2], establishes the possibility of intestinal infection of such waters.

An idea of the extent of this bacterial infection may be gained from recent work. Burrage[3] found that the swimming tank water at the Purdue Gymnasium contained 109 bacteria per cc. (no B. coli present), when freshly drawn. After use by 30 bathers, supposed to wash with soap before going into the tank, the count was 109,200 organisms per cc. with B. coli present. Professor Kister[4], in an investigation on the waters of the Hamburg bathhouse, found 57 colonies and no B. coli on freshly filling the tanks, whereas after 74 people had bathed, the colonies increased to 1,800, with B. coli present. In the afternoon of the same day, after 494 more individuals had used the baths, the count reached 64,400 per cc. Dr. Selter of the University of Bonn reports the following experiment:[5] a stoker bathed in a tub three minutes, using no soap. Before the bath the water ran 24 bacteria per cc. with no B. coli present. After the bath it ran 1,900 bacteria and 40 B. coli per cc.

Table I. gives counts made upon samples taken from the swimming tank of the Northwestern University Gymnasium, during the weeks commencing Feb. 13, 1911, and March 6, 1911, respectively. No bleach or disinfectant of any kind was added to the water during these periods. The samples were taken from the spring board, about 6 ins. below the surface of the water. Plates from appropriate dilutions were made immediately upon nutrient agar. These were incubated at 20° C. for 72 hours. This tank, made of glazed tiling, is equipped throughout in the most modern manner with Loomis-Manning filters, attached alum chambers for softening, side troughs, external drains, automatic heating system, etc. Provisions for showers with soap, are ample and convenient. The capacity of the tank is 66,500 gals. It is emptied and washed each Saturday afternoon and refilled by Monday morning. It is then used for a week by an average of some 500 bathers, about one-fifth of whom are women.

It is noted in both these series that there is a gradual rise in bacterial content until about the middle of the week, after which there is a fall. This is probably due to the Malthusian Law applied to bacterial life. Organic food material increases only from contamination by bathers, whereas bacteria increase from this cause and

TABLE I.—BACTERIAL CONTENTS OF UNTREATED WATER FROM SWIMMING POOL AT NORTHWESTERN UNIVERSITY, IN FEBRUARY AND MARCH, 1911.

	No. using tank.	Bacteria per cc.	Gas producers per 10 cc.
Monday, 6 p. m.	113	3,600	..
Tuesday, 6 p. m.	100	22,800	..
Wednesday, 6 p. m.	132	25,000	..
Thursday, 6 p. m.	97	16,800	..
Friday, 6 p. m.	140	4,000	10
Saturday, noon	28	8,300	6
No Bleach Added.			
Monday, 6 p. m.	100	4,200	..
Tuesday, 6 p. m.	89	180,000	..
Wednesday, 6 p. m.	81	223,000	..
Thursday, 6 p. m.	88	15,200	..
Friday, 6 p. m.	114	8,000	..
Saturday, 12 noon	31	No sample	..

reproduction. Thus an inhibiting force sets in, which has been recognized to be a considerable factor in the self purification of streams.[6]

At first glance the above data would seem to reflect a flagrant disregard of the shower requirement before bathing. It is true that a few students are devoid of all sense of social responsibility, and a few others do not yet realize that a gymnasium swimming tank is a place for exercise, rather than for cleansing the person. One student was overheard to remark that he didn't intend to take the preliminary shower any more, as he had omitted it, on several occasions, when short of time, without any ill effects to himself. Observations through several months, however, lead me to believe that such individuals are rare. At least it is believed that the conditions in the Northwestern swimming tank, upon which this investigation is based, are fairly typical, in respect to use and abuse, of University swimming tanks in general.

Surgeons best appreciate the difficulty of freeing the human body externally of bacteria, and that the preliminary shower equipment of the average swimming tank is decidedly inadequate for this purpose is evident from the data.

Theoretically, a swimming tank water should be as pure as a drinking supply, for while not intended primarily for the latter purpose, the novice so uses it freely.

The sanitary chemical analyses given in Table II. show a progressive contamination of the water during the week and thus tend to confirm the bacterial counts.

Commercial bleaching powder is now being used in some 125 cities of the United States for sterilizing public water-supplies.[7] The efficiency of such a method applied to swimming tanks might appear obvious at first glance. There is, however, this essential difference, the swimming-tank water becomes more highly contaminated than the average public drinking supply, and is being continuously recontaminated. A public water-supply, on the other hand, once sterilized may be kept so until delivered. Questions of quantity, method and frequency of application, therefore, arise anew in the case of the swimming tank.

As to the sterilizing of drinking supplies with bleaching powder, the following points are notable: The quantity used—5 to 15 lbs. per million gallons, is so small as to be inconsequential after reaction. The original material acts quickly—undoubtedly through the liberation of oxygen, from the reaction of the available chlorine and water resolving itself into calcium hydroxide, which in turn is converted into the carbonate and chloride. While not producing an absolutely sterile water, there is a substantial destruction of all objectionable bacteria, particularly those of intestinal origin. The efficiency of such a treatment in all cases is greater than the figures show, because of the selective action of bleach upon pathogens. It is generally conceded by sanitarians that spore forms are not affected by hypochlorite treatment, but these as normally found in water are not pathogenic to man.

It is believed that the tests reported in Table III., made upon using commercial chloride of lime or bleaching powder, establish the wisdom of its application from twice to three times a week in 1-lb. quantities to a tank of the capacity and usage represented in that of the Northwestern gymnasium. The bleach used in the work averaged 33% available chlorine, corresponding to 0.6-part per million of chlorine. One pound to 66,500 gals. corresponds to 15 lbs. per million gallons, an amount of bleach not infrequently used in treating public drinking supplies. In some cases it was added in a suspension, 1 lb. to 5 gals. of water; in others it was sprinkled dry from the edge of the tank and springboard. No advantages were noted in the former method, while the latter is more convenient. The counts were made as before stated, and

TABLE III.—BACTERIAL RESULTS FROM HYPOCHLORITE TREATMENT OF WATER IN SWIMMING POOL OF NORTHWESTERN UNIVERSITY, IN FEBRUARY AND MARCH, 1911.

Day and treatment, week beg. Feb. 6-11.	No. using tank.	No. of bacteria per cc.	No. of gas producers per 10 cc.
Using Bleaching Powder at the Rate of 15 lbs. per Million Gallons.			
Monday, 9 a. m., tank filled Sunday not yet used	..	2,310	..
Monday, 6 p. m., tank used all day, just before 1 lb. bleach added	92	2,730	..
Tuesday, 9 a. m., tank not yet used	76 (to 6 p. m.)	175	..
Wednesday, 9 a. m., tank not yet used	87 (to 6 p. m.)	8	..
Thursday, no sample taken	92	...	..
Friday, 9 a. m.—no more bleach having been added	111 (to 6 p. m.)	5,000	..
Saturday, no sample	24 (12 noon)	...	..
Monday, 6 p. m., just before 1 lb. bleach added	119	2,000	2
Tuesday, 9 a. m., before tank used	...	20	0
Tuesday, 6 p. m., no sample	75	...	..
Wednesday, 6 p. m.	111	6,000	5
Thursday, just before 1 lb. bleach added	82	20,000	10
Friday, 9 a. m.	...	13	0
Friday, 6 p. m.	101	14	2
Saturday, 12 noon	26	16	2
Week beg. March 6/11:			
Monday, 6 p. m.	111	2,200	1
Tuesday, 6 p. m., just before 1 lb. bleach added	96	39,600	6
Wednesday, 9 a. m.	...	900	1
Wednesday, 6 p. m.	118	2,160	8
Thursday, 6 p. m., just before 1 lb. bleach added	70	9,850	8
Friday, 9 a. m.	...	900	0
Friday, 6 p. m.	97	1,860	10
Saturday, 12 noon	38	7,200	10
Using Bleaching Powder at Rate of 22½ lbs. per Million Gallons of Water.			
Week beg. Feb. 27/11:			
Monday, 9 a. m.	108	3,200	2
Monday, 6 p. m., just before 1½ lb. bleach added	...	4,800	2
Tuesday, 9 a. m.	...	26	None
Tuesday, 6 p. m.	80	630	None
Wednesday, 9 a. m.	...	290	None
Using 7½ lbs. of Bleaching Powder per Million Gallons.			
Week beg. Feb. 27/11:			
Wednesday, 6 p. m., just before ½-lb. bleach added	126	26,000	3
Thursday, 9 a. m.	...	10,000	None
Thursday, 6 p. m.	90	8,000	None
Friday, 9 a. m.	...	20,000	None
Friday, 6 p. m.	100	130,000	None
Saturday, 12 noon	29	18,000	..

TABLE II.—SANITARY CHEMICAL ANALYSIS OF THE SWIMMING TANK WATER FOR THE WEEK BEGINNING DEC. 14, 1910.

(Parts per Million.)

	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
No. using tank	111	119	132	116	156	48
Volatile matter on ignition	13.6	18.0	24.0	20.0	28.4	15.6
Chlorine	9.8	9.8	8.58	9.8	11.07	12.26
Albuminoid NH_3	.042	.060	.07	.07	.08	....
Free NH_3	.0297	.016	.0518	.0749	.0081	.0912
Nitrites	None	Trace	Trace	Trace	Trace	Trace (more marked)
Nitrates	.116	....	....	.120	.112	.116
Total solids	134.8	152.4	176.0	133.2	132.0	179.2

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[1]S. Burrage, Proc. Ind. Acad. of Science, 1909; cf. also Eng. News 63, (24) 740.

[2]Burrage: Eng. News, 63, (25) 740. Kister & Fromme: Gesundh. Ing., 33, 51.

[3]Burrage: Eng. News, 63, (25) 740.

[4]Kister & Fromme: Gesundh. Ing. 33, 51.

[5]Selter: "Zur Hygiene der Hallenschwimmenbade." Rundschau, Dec. 1, 1908.

[6]Jordan: Decennial Publications, Univ. of Chicago, 10, 82.

[7]Shenton, H. C. H.: Surveyor, Suppl., 21-2. Editorial, Eng. Rec. 61, 653. Johnson, G. A.: Eng. Rec. 62, 321. Woodhead, G. S.: Proc. Camb. Phil. Soc., 15, 559-73. Jordan, H. E.: Proc. Ill. W. Survey Assoc. 1910, 200-6. Jennings, C. A.: Eng. Rec. 62, 340. Johnson, G. A.: Eng. News, 64, 342.

the gas producers determined in the usual manner.

The results obtained by using 1½ lbs. of bleach (middle part of Table III.) do not show a much higher degree of sterilization nor a more lasting effect. On the other hand, there was produced a noticeable odor of hypochlorous acid in the water and room for some twelve hours.

The ½-lb. of bleach used on the following Wednesday (see last part of Table III.) seemed insufficient so far as the total count is concerned, but even with this quantity, there was a noticeable absence of gas producers, indicating the selective action of the chemical as stated in the literature.

From the discussion it would seem that an indoor swimming tank, of the capacity, usage and frequency of filling, represented by that of the Northwestern gymnasium, is a possible menace to the health and well-being of those using it. It is believed that the data submitted establish the wisdom of treating such a tank from two to three times a week, with 1-lb. quantities of bleaching powder, or chlorinated lime. Since the conditions in the Northwestern tank are, without doubt, typical of the average indoor swimming tank, the foregoing statements are believed to be of general applicability. The quantity of bleach used should, however, be adapted in each case to the degree of contamination, as shown by bacteriological counts.

The Need of Professional Cooperation Among Engineers.

By ARNOLD C. KOENIG,* Assoc. M. Am. Soc. C. E.

Nearly every engineer can recall incidents in his career which indicate that the ethics of professional cooperation among engineers consists of ideal theories which find too little practical application in ordinary affairs.

The engineers to whom the full measure of success and recognition has been accorded, which their force, ability and achievements have merited, and to whom the fickle goddess "Opportunity" has paid the additional tribute of fame, through the publicity which properly attaches to undertakings of conspicuous magnitude, are, comparatively speaking, only a mere handful in number.

The niceties of professional ethics, which are generally illustrated in the activities of these few, are therefore not more representative of the conditions which influence relations between individuals in the great body of engineers, than are the conspicuous achievements of these few representative of the routine technical duties which occupy the attention of the average engineer in his struggle for existence.

The measure of success which crowns individual effort in average engineering work, is generally short of that which would result from cooperation with other engineers of ability, or with specialists. Therefore, in the long run, it benefits an engineer less to attain a fair measure of personal success through individual effort, than to take advantage of every opportunity to achieve the greater economic success in the final results of any undertaking through consultation with others, thereby raising the measure of public respect for engineering service.

In important litigation, involving financial interests of far less magnitude than are involved in the development of an average engineering project, the employment of associate counsel is accepted as a matter of course.

When a physician encounters puzzling symptoms, or his patient's condition reaches a critical stage, he suggests the advisability of calling some other physician, or a specialist, into consultation, to verify the correctness of his diagnosis. His standing is not in the least impaired by such a step; on the contrary, the confidence of his patient is generally increased. The ethics of the situation are well established, and ensure that the physician who is thus called into consultation will not state the result of his diagnosis, nor express any definite opinion of the case, unless requested to do so by his colleague after it has been discussed in private, nor will he express any unfavorable or dissenting opinion, except in the presence of, or with full knowledge of his colleague.

The young engineer who "hangs out his shingle" to engage in independent practice, feels impelled to "play a lone hand," because of an intuitive mistrust of the practical observance of ethical principles which other engineers would accord to his interests if he sought consultation with them. Therefore, whenever he is entrusted with the execution of some undertaking in which he has had little, if any actual experience, he shrinks from consultations, which he fears would afford more experienced engineers opportunities for surreptitious self-aggrandizement, and carries out the commission according to his own best judgment in the manner which he believes is least likely to betray his own limitations.

From discussions of this subject with engineers of various ages, localities and phases of professional activity, the writer concludes that this instinctive mistrust of fellow-engineers is general among the very large body of engineers engaged in private local practice. If this be true, the fact is deplorable.

"Success" for the engineer does not, as a rule, involve the large measure of pecuniary reward which accompanies a similar degree of success in other professions, except in cases where he combines commercialism and the promoter's instinct within the sphere of his professional activities. An analysis of results in other professions, indicates that *cooperation with mutual observance of ethical principles*, will result in raising the measure of value of engineering service.

"ESPRIT DE CORPS."—The assistant who is entrusted with the execution of some important detail of a large undertaking, which involves original investigation, experiments, or technical research along new lines, and, who executes his trust with marked success, nurtures the secret idea that his ability is of a higher order than that of his chief who prepared the task, and whose discernment singled him out as the proper one to be charged with its fulfillment. The final comprehensive report on an undertaking which involves a number of such details, masterfully executed, is an achievement of the highest professional order, and the chief whose narrow egotism would seek self-aggrandizement without due recognition of such work by his assistants, would be a rare exception.

The assistant, on the other hand, who recognizes the fact that he is merely an important wheel in the entire mechanism thereby demonstrates that he is of the caliber which fits him for the responsibilities of "chief" on some future undertaking.

CONSULTATION.—When a young engineer is entrusted with the entire responsibility for the designing and construction of some piece of engineering work, he naturally feels an inward sense of his own limitations. He can do himself no greater injustice than to attempt to hide those limitations, to the injury and at the expense of his client.

The prominent engineers who, by reason of their experience and recognized abilities, are qualified for honorable distinction as consulting engineers, are men of broad caliber mentally, ethically and professionally. The young engineer who has prepared a careful outline of any piece of important engineering work should request his client's permission to arrange with some consulting engineer for a general examination and approval of his plans, together with suggestions for possible improvements.

The cost of such consultation is small as compared with the value and of the service rendered. The young engineer whose plans are thus approved by an "expert," will proceed with their execution with greater self-confidence, his client will have more confidence in his ability, and he will thus achieve a larger measure of success than would otherwise be his. It is when a young engineer's apparent lack of self-confidence, together with his known limitations of practical experience, cause his client to consult with some rival engineer, that the instances occur in which the engineer so consulted will suggest unimportant changes of the plans, with a general air of professional importance, for the mere petty self-satisfaction of displaying his knowledge at the expense of his colleague, the engineer in charge.

Consultations should not be confined to the large and important matters alone, because frequent consultations among engineers on the smallest items of uncertainty connected with all engineering works, would eliminate most of the little errors which are unknown, or overlooked until construction reaches the stage where these little evidences of carelessness or inexperience, become apparent even to the layman, thereby arousing his contempt. Their elimination, on the other hand, would result in raising the general level of confidence in and respect for engineers and engineering services.

A SIMPLE ILLUSTRATION OF MINOR CONSULTATION.—During the early '90's, when hard times, drought and populism held full sway, the writer returned to his home town (a thriving Western city of about 8,000 population) to accept appointment as city engineer, from a mayor and councilmen who had known him during his childhood.

Not only, therefore, was he hampered by the stress of hard times which served to intensify the narrowness of councilmanic interference in necessary engineering improvements, but also the old adage about the prophet being without honor among his own people, is too mild to express the difficulties of a "cub" engineer dealing out dignified professional advice to councilmen who knew nearly every phase of his childhood.

Suggestions for slight modifications of the general plans in the extensions of small lateral sewers received ponderous consideration from aldermen who hesitated not to undertake sweeping criticism of the engineer's ideas. Instead of wrangling over these small technical matters, a sense of humor prompted the writer to suggest to the council that matters of such grave moment should not be decided offhand, but that Mr. R., a well-known consulting engineer, be called in consultation. The opportunity thus to demonstrate the superiority of experienced councilmanic judgment over that of an inexperienced young engineer was immediately grasped.

During the conference, from which the writer purposely absented himself, in order that the situation lose none of its flavor of absurdity, numerous questions were answered by Mr. R., until finally he suggested that they come to the matter upon which he had been called, as there was nothing involved in the simple details under discussion, which the city engineer was not as competent to decide as any engineer in the country.

Getting no light from the aldermen, he called at the city engineer's office after the close of the conference, to await the arrival of his train, and asked: "Can you tell me what in thunder I was called here for? None of the council seems to know."

The writer then explained why he had been instrumental in having Mr. R. called for such a seemingly absurd consultation. He expressed his views upon the mutual advantages which would result from closer cooperation between experienced and inexperienced engineers, using the case in hand to illustrate the real importance of seemingly unimportant details. They then discussed the indefinable sense of professional aloofness which seems to prevail among the rank and file of engineers, and the narrowness which causes the young engineer to shrink from following the example of the young physician, who may call an older physician into consultation to their mutual gain in prestige, as well as their mutual benefit, both professional and financial.

Mr. R.'s visit for an apparently useless consultation detracted nothing from his prestige, and his fee was the same as if he had been called to decide questions of greater technical moment. The disagreeable lack of councilmanic confidence in the writer's professional ability was so effectively removed that upon subsequent occasions, when he wished to have Mr. R. called in consultation upon puzzling technical questions, it was difficult to persuade the council that there was sufficient reason for it to justify the expense.

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CORROBORATIVE EVIDENCE.—A tour through a number of young Western cities and towns will demonstrate that simple improvements such as curbs, gutters, culverts, grades, etc., display the originality of inexperience (and corresponding lack of uniformity) and that the relatively small additional expense for the services of consulting engineers to advise the local engineers in charge would in all cases have ensured better results, and in many instances have saved several thousands of dollars expended on construction which will at some future time be changed.

The average young city engineer, in his earnest desire to attain the best results, must grope his way through a mass of special (often conflicting) information in text books and current technical publications; but, he would gladly avail himself of the advantage of consulting with an experienced engineer if he could feel assured that his own prestige would not be impaired.

It is to be hoped that frequent discussion of the subject, with publication of specific examples of personal experiences, will result in a proper appreciation of the fact that *cooperation*, with the practical observance of ethical relations, between local engineers and consulting engineers from the nearest large cities, will materially raise the standard of engineering results; and, that no system of local improvements of any kind should be undertaken without the services of a consulting engineer for the few hours or few days that may be required for him to examine and approve the general scope and details of the plans.

Copying or modifying the plans of similar improvements which are considered satisfactory in some neighboring city, does not ensure the best results.

Among our larger cities, with their systems of municipal improvements which have been developed under a succession of city engineers, each exercising his individual judgment, it is becoming the custom to employ a board of consulting engineers to report upon necessary revisions, and comprehensive plans of general improvements, which will then be carried out under the direction of the city engineer. The value of this is obvious, and engineers in the smaller communities would do well to urge the adoption of a similar custom, through frequent consultations with specialists.

It is to be regretted that the rapid growth of young Western communities, with their feverish haste to outstrip rival communities in the construction of municipal improvements, has developed a class of self-styled "consulting engineers," who hasten from town to town, wherever waterworks, sewerage or other improvements are contemplated, and with plausible solicitation secure employment to furnish plans and specifications.

Many of these self-styled "consulting engineers" are incompetent (some are unquestionably dishonest) and their claims of extensive experience are based upon successions of designs, slightly modified to fit various localities, all of which include the same errors and features of inadequacy. Many Western cities and towns have wasted large sums of money in the construction of inadequate and badly designed municipal improvements under the direction of such men.

The utter disregard of men of this class for the common principles of professional ethics in their relations with each other, and in their dealings with the local engineers in the various communities, makes it all the more difficult to establish proper and legitimate relations between these local engineers and responsible, honorable consulting engineers. The ultimate realization of the public that it has been duped by these professional pirates, results in intensifying public mistrust of the engineering profession in general.

Satisfactory results are generally assured, when the plans for local improvements are entrusted to some ambitious local engineer, under the advice and general direction of a consulting engineer of established reputation from some large city, and the total cost of professional work under such arrangement would be no more than the regular fee which would be charged by any competent engineer to furnish the plans complete. This, then, would seem to be the proper and equitable basis of cooperation in such matters, not only in the interest of the public, which pays the bill, but also in the interest and general advancement of engineering as a profession.

Every engineer can count a large proportion of his acquaintances (including men in other professions) who have expressed regret that they did not take advantage of opportunities, or past inclinations, to embrace engineering as their profession. On every hand, one may find evidence that engineering, as a profession, is held in high esteem. It is for engineers themselves to cultivate an "esprit de corps," and to observe high standards of practical ethics in professional cooperation. Then will the general respect for the profession assume the more practical form of increased appreciation of individual merit and greatly increased remuneration.

ENGINEERS, CONTRACTORS AND MANUFACTURERS.—The engineer, the consulting specialist, the manufacturer and the contractor are each important parts of the machine, which should be operated in the interests of those who ultimately pay the bill, and harmonious cooperation between all of these parts is essential for the attainment of the highest efficiency in the final results.

Engineers' specifications were formerly so strictly drawn and contained so many "reservations" (to use a mild term) which were subject to the sole interpretation of the engineer, that the "personal equation" was the controlling element in their practical execution.

These "reservations" and indefinite general instructions were merely shields behind which an engineer could hide his limitations of exact knowledge and experience, and placed the burden of expense for "experimental" construction upon the contractor. The contractor was required to furnish the practical knowledge of details which the engineer lacked, and he frequently paid the penalty of reconstruction on portions of the work with which, in the absence of definite specifications, he had foolishly proceeded according to his best judgment, thus affording the advantage of "hind-sight" to the engineer, and enabling him to make practical observations on this "experimental" construction, thereby determining "the method in which the work should properly be done," and to order it thus.

In drawing up specifications, engineers always appropriated the power to "make or break" the contractor, unless the matters involved in controversy were of sufficient importance to seek adjustment in a court of equity. It behooved the contractor, therefore, to invoke the powers of diplomacy (often of dishonesty and subterfuge) to adjust this unfair balance—to "wine and dine" the engineer, to assume a subservient attitude, to take advantage of opportunities to secure a laxity of inspection, to give subtle guidance to the engineer's interpretation of indefinite clauses—in fact, to exercise all of the ingenuity of natural diplomacy to cause a shifting of the center of oscillation of the pendulum of unfairness, from the position of unfairness against him, to a position of unfairness in his favor, and against the "owner," who would thus pay the penalty of an unfair contract in illegitimate profits on inferior workmanship and materials.

Under such conditions successful contracting on a large scale required men of broad mental caliber, with qualifications which generally made them superior to the average engineer in all respects, except the matter of "book-learning," which expression aptly described the meaning and status of education in the conceptions of those who looked upon mathematical and theoretical knowledge as accomplishments of doubtful practical value.

Engineers who were attracted by the large profits which contractors frequently made, and who persuaded themselves to engage in the degrading business of contracting, temporarily, for the purpose of acquiring sufficient wealth to enable them to pursue their professional career thereafter with comfortable absence of financial worry, generally found that it was impossible for them to adapt themselves to the complete reversal of status which such unfair conditions necessitated, therefore failure was inevitable. Thus arose the popular belief that the training of an engineer absolutely unfitted him for the business of contracting.

Such failures, however, resulted in permanent good, because they served to make their victims broader-minded engineers by giving them an insight into the unfairness of the handicap under which an honest contractor was compelled to struggle to save himself from ruin, thus hastening evolution toward present conditions.

Various phases of engineering-contracting now involve the highest degree of special technical training, and many large manufacturing and contracting concerns not only employ men of the highest order of technical attainments, but also maintain courses of special instruction, with practical technical apprenticeship, for the further development of men who enter their employ after securing a preliminary fundamental education at some technical school.

Conspicuous examples of the marvelous development which has resulted from this policy are furnished by the large electrical concerns, steel mills, bridge and structural shops, etc. Catalogs of machinery, materials and engineering specialties are no longer compiled on the principle which governs the production of a mining prospectus, but generally contain reliable, practical information of scientific value.

The province of the engineer in large undertakings has become largely that of determining the general requirements of local conditions, and serving the best interests of his clients by preparing a general design, or construction plan, which embodies a judicious selection, and proper combination of materials, machinery and special appliances, which have been perfected and standardized by specialists.

Frank cooperation between the engineer and various manufacturing concerns is therefore an important element in the attainment of the best results in any large undertaking. The engineer of limited experience should not attempt to make definite decisions regarding the type of machinery, and the details of arrangement and installation of special features, without frank consultation with the specialists, or "experts," who are employed by all reliable concerns for that purpose. Keen competition makes the interests of the manufacturer practicaly identical with those of the engineer and his client in the attainment of the highest degree of economic success in the final results.

Therefore, in all phases of professional activity, cooperation is the keynote of success.

CAST-IRON SURFACED WITH ALUNDUM is being used for stair treads and numerous other purposes where a rough, wear-resisting surface is desired. Loose alundum is simply spread in a thin layer over the surface of the mold in which the stair tread or other piece is to be cast. The molten metal, upon entering the mold, penetrates between the grains of alundum, which thus become firmly embedded at the surface of the casting. The resulting surface is ideal for stair treads as the sharp, projecting points of alundum take a firm grip on sole leather. The roughness of the surface can be regulated by varying the coarseness of grain of the alundum. A rounded nosing can be provided over the edge of the stair, which is unprotected by the usual tread.

Stair treads of this material installed on the northeast stairway of the Fulton Street subway station Dec. 15, 1909, are still in good condition. A comparative test of alundum-metal stair treads and some of another standard make was made last year on a much used stairway in a railway depot at Hoboken, N. J. The competing treads were placed on alternate steps of the same stairway. The alundum-metal treads remained in good condition after nine months' service, while the others were completely worn out after six months' service.

Alundum metal has also been used with success for the side plates of centrifugal-pump casings on suction dredges, for culm pipes in coal mines, for jig crates in coal washing and for elbows in ash-ejector pipes on steamboats. It was invented by Mr. Charles B. Jacobs, of New York City, who is also the inventor of the process of producing pure corundum ("alundum") artificially by fusing bauxite (aluminum oxide) in an electric furnace. The alundum metal is being put on the market by the American Abrasive Metals Co., of 50 Church St., New York City.

The Financial Possibilities of Hydro-Electric Developments in the Central West.*

By PAUL M. LINCOLN.†

This being an Ohio society, the members are particularly interested in conditions which surround possible hydro-electric developments in that state. However, the topographic and hydrographic conditions which obtain in the State of Ohio are also typical of practically all the states lying in the Mississippi Valley. Such general comments, therefore, as are made in this paper will apply not only to conditions in Ohio but also to practically all states where similar conditions prevail.

The first thing that any power development must take into consideration is the absolute necessity of a continuous supply of power. Reliability and continuity of supply is the first requisite, the sine qua non of success. In former years the brookside grist mill or saw mill was more or less common on many of the streams in Ohio. These operations required a comparatively small amount of power, and continuity of supply was, under the conditions then existing, not absolutely necessary for success. However, most of these small developments of power have fallen into disuse and practically all of them have been abandoned. At the time of these developments the users of this power were content to put up with delay in the grinding of their grain or the sawing of their logs, if necessary. Under modern conditions, however, the idea of waiting for a rain to start stream-flow before power can be obtained is so absurd that it can be dismissed at once. It is the first requisite that the manufacturer shall have power to drive his mill whenever he demands it, or that the citizens shall have his electric light upon the turning of the switch. In this respect, conditions now and 50 years ago are entirely different. It is this demand for continuity of power upon which hinges the availability of hydro-electric developments under present-day conditions.

A study of the rainfall and run-off conditions that apply to the middle West is essential in arriving at a proper valuation of water power. There is given below a table of the mean rainfall and run-off as recorded for the Muskingum River basin at Zanesville, O. This record covers the eight years of 1888 to 1895, inclusive. The table includes not only the average for the eight years above given, but also the average of the same quantities for the three dry years of 1889, 1894, and 1895. This data is taken from the Eighteenth Annual Report of the United States Geological Survey issued in 1897. The drainage area above the point where these records were taken is 6,565 sq. miles. This drainage basin may be taken as typical of those which exist throughout the middle West. Although the rainfall and run-off are shown by record to be considerably higher for the mountainous and forest-clad district of the Alleghenies, yet when we are considering the comparatively level tracts which are typical of most of the central Western States, records will show that the conditions of the drainage basin I have taken are typical.

Month.	Mean for 8 years 1888 to 1895, inclusive.		Mean for 3 dry years, 1889, 1894, 1895.	
	Rainfall. ins.	Run-off. ins.	Rainfall. ins.	Run-off. ins.
December	2.34	.821	2.37	.910
January	3.27	1.005	3.24	1.521
February	3.34	2.529	1.80	1.241
March	2.85	1.907	1.93	1.104
April	2.69	1.274	2.15	.739
May	4.33	1.426	3.02	.371
June	4.42	.870	3.26	.349
July	3.85	.467	3.21	.296
August	3.25	.338	3.13	.148
September	3.22	.488	3.56	.140
October	2.87	.502	1.97	.105
November	3.22	.778	3.44	.334
Totals.....	39.65	13.005	33.08	7.258

A study of the above table is interesting. The most noteworthy feature is the fact that for the three months of August, September and October the run-off reaches a comparatively low figure. A better idea of the conditions will be obtained by referring to the accompanying diagram. These curves show in dotted lines the average for the three dry years. These curves show plainly the marked difference between the run-off of the dry summer months and that of the remaining months of the year. Referring now particularly to the months of August, September, and October of the three dry years, it will be noted that the average monthly run-off for these three months amounts to 0.131-in. Considering that this is the average for nine months (three consecutive months of three different years) it is certainly not too radical to assume that one cannot depend upon a continuous amount of water at the minimum flow of the stream of more than 0.1-in. per month. As a matter of fact, it is quite probable that this estimate is higher, rather than lower, than what would actually obtain. The consideration of continuity of power mentioned in the foregoing makes it obvious that it is safe to rely upon only that run-off which can be depended upon continuously throughout every part of every year. The exceptions to this statement will be discussed later in this paper.

The above table shows that the average rainfall, if distributed equally throughout the whole year, would amount to about 3.3 ins. per month and that the average run-off for the same conditions would be about 1.1 ins. per month. It is evident, therefore, that we can depend for continuous power upon only about 9% of the average run-off or 3% of the average rainfall.

Now let us see what a run-off of 0.1-in. per month will mean when reduced to terms of power. The run-off of 0.1-in. per month is equivalent to almost exactly 0.09-sec.-ft. per sq. mile. One sq. mile with a run-off of 0.1-in. per month, falling through a head of 1 ft., will give a theoretical energy of about 0.01-HP. Taking into account the efficiencies of the water wheel and such other apparatus as it is necessary to use to utilize this power, it is evident that a continuous supply can be obtained of not more than 0.005-KW. for each sq. mile of drainage area for each foot of fall over which this water can be used. For instance, if it were possible to obtain a point at which the run-off from the entire State of Ohio (41,060 sq. miles) could be utilized over a 10-ft. fall, it would be possible to obtain a continuous power supply of only about 2,000 KW. at the minimum flow point. This seems an astonishingly small result but is nevertheless absolutely unassailable, if it is conceded that a run-off of 0.09-sec.-ft. per sq. mile is all that is available. The data quoted in the foregoing is in my opinion sufficient to justify the statement that not more than this minimum will be continuously available.

It might be noted that the above figure is for a continuous power supply. As a matter of fact actual conditions do not demand a continuous supply throughout all hours of the day. Considerably more power is demanded

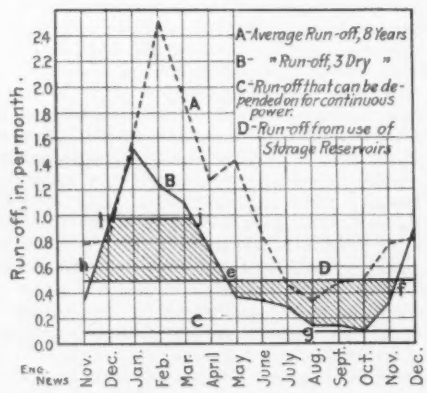
A-Average Run-off, 8 Years
B- " Run-off, 3 Dry "
C-Run-off that can be depended on for continuous power.
D-Run-off from use of Storage Reservoirs
Run-off, in. per month.
Eng. News
Nov. Dec. Jan. Feb. Mar April May June July Aug. Sept. Oct. Nov. Dec.

Diagram Showing Average Run-Off per Month for the Three Dry Years, 1889, 1894, 1895, for Muskingum River Basin at Zanesville, O.

at certain hours than at other hours, or in other words, the load factor is considerably less than unity. For an ordinary lighting load 30 to 40% load factor might be expected. Only a relatively small amount of pondage is necessary for equalizing a continuous supply of water so as to take care of the variations in daily load demanded by a daily load factor of 30 to 40%. This consideration would increase the maximum power which would be available at certain hours of the day by conserving the water for the remainder of the day. A 30% load factor would mean that 3⅓ times the continuous supply can be depended upon at the maximum, and a 40% load factor would mean 2½ times.

A further study of the conditions that surround Ohio streams indicates that the average fall per mile of those streams is comparatively small. On the lower reaches of the streams the average fall varies from about 1 ft. to 6 ft. per mile. For instance, the Muskingum River has a length from Zanesville to the Ohio River of about 66 miles. The fall in the same distance is about 97 ft., showing an average of about 1.5 ft. per mile. Conditions on other streams are very similar. The upper reaches of some of the smaller streams run as high as 15 ft. per mile, but to obtain so large a fall one has to ascend the stream until the drainage area becomes inconsequential. What is gained, therefore, in fall is lost in the amount of water which becomes available.

With the above data before us, it is not very difficult to arrive at the conclusion that States such as Ohio offer in general an exceedingly poor opportunity for water-power development. Not only is it impossible to obtain any point where a reasonably large drainage area becomes available at a reasonable fall, but also even when a development is made, the extra dry year may come along and reduce the energy that can be taken from the development to such a point that it is not dependable. It will be understood, of course, that this remark is of a general nature. There may be exceptions to this general statement, and where such exceptions exist the conclusions arrived at will of course not apply. Such an exception exists for instance at Niagara, where not only is the fall large but also the amount of water available is not only large but uniform throughout the entire year. This uniformity of flow is of course obtained by the equalizing effects of the Great Lakes. However, there is only one Niagara and the conditions which apply at that point are good for that point only.

There are two plans which may be adopted, both of which will assist in the utilization of such water power as is available in the relatively flat and variable rainfall localities under consideration. One of these plans is to build reservoirs for the purpose of impounding the water during flood periods and releasing it during the low-water periods, thus equalizing the flow of the streams.

The second is to use water-power plants as auxiliaries for steam operation, depending upon each kind of plant as a relay upon the other. In practice, both of these plans may be and are utilized.

Referring now to the first of these remedies, what may we expect by its adoption? Suppose for instance, we wish to increase the run-off available from 0.1-in. per month, which represents about 45% of the average run-off. What would be necessary in the way of reservoirs, etc., to accomplish this result? The diagram indicates in a general way what is necessary. The line "C" indicates the low-flow period of the stream, namely 0.1-in. per month. The line "D" is drawn at the average flow point of 0.5-in. per month. The cross-hatched area "e, f, g" represents the amount of water which would have to be released during the summer months of the average dry year to raise the flow from what records show really does exist during such years to the 0.5-in. per month we have assumed. In order to release this amount of water, it would be necessary to impound an amount of water approximately indicated by the cross-hatched area "e, h, i, j." On account of the losses which necessarily take place by evaporation and seepage, it is necessary that the amount of water stored exceed that released by some 20%. The necessity of at least this margin may be readily arrived at when it is considered that the evaporation from any body of water amounts to 4 to 5 ft. per year in the climate of the Mississippi Valley.

An inspection of the diagram will show that the depth of the cross-hatched area "e, h, i, j" is about 0.4-in. In other words, it becomes necessary to store an amount of water represented by a depth of 0.4-in. over the entire water shed. If the reservoirs available have an area of 1% of the water shed, the depth of water which will be necessary to draw off from them for equalizing purposes would amount to about 40 ins. or 3⅓ ft. In other words, in order to equalize the stream flow from a run-off of 0.1-in. per month to 0.5-in. per month, it would require an area of reservoir equal to 1% of the area of the water shed, said reservoir to have a draw-down of at least 3⅓ ft. or the equivalent of this.

In a State so well developed agriculturally as Ohio for instance, the task of securing so large a proportion of water shed for reservoirs must be recognized as a difficult one. Also the expense attached to impounding this water must necessarily be high, not only on account of the value of the lands themselves which will be covered by water, but also on account of the construction of the retaining dams and other works necessary for impounding and releasing the water.

The real solution of the problem will come, if it comes at all, by considering that water-power developments are to be used as auxiliary to steam plants. The question of just how far this plan of operation can be carried is a large problem, and I can only touch the edges of it in this short paper. However, there are some points which may be pertinently discussed.

If we consider that the water-power plant is simply an auxiliary to a steam-power plant, it at once becomes necessary to install duplicate machinery for a considerable part of the load. We must provide steam-driven machinery to carry the load during the periods of insufficient water. The question at once becomes, will the installation of the water-power plant pay? In order to get a basis for answering this question, we will first assume that the duplication of machinery is complete, that is, that the water power reduces to zero during a part of the year and that it is therefore necessary to have a steam plant that can carry the entire load during such period. Later we can see how a departure from this assumption will affect our conclusions.

A brief consideration will show that practically the only saving that can be obtained by the operation of a water-power plant as an auxiliary to a steam plant is the saving of the fuel which would be burned if the water plant were not operated. The item of labor for attendance will certainly not be reduced. When not operating the steam plant, the men will be operating the water plant. In fact the attendant expense is apt to be increased since during a considerable part of the year both plants would have to be operated, making practically a double crew necessary. Supplies (such as oil, waste, etc.) would certainly not be reduced by the operation of the double system. Maintenance and repairs will not be reduced either, since the up-keep on the steam plant is apt to be even higher if run intermittently than

*From a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers, at Youngstown, Ohio, May 19, 1911.

†Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

if run continuously. As a conclusion, therefore, it may be safely assumed that the saving in fuel is the only one that can be obtained by the operation of the auxiliary water-power plant.

Now let us see where we come out if we assume that all the fuel could be saved by operating the water plant.

We will assume that the cost of fuel to produce a KW-hr. in our steam plant is 0.5-ct. This 0.5-ct. per KW.-hr. for fuel means 2 lbs. per KW.-hr. of coal at $5 per ton; 3½ lbs. of coal per KW.-hr. at $3 per ton; 5 lbs. of coal per KW.-hr. at $2 per ton; or 6⅔ lbs. of coal per KW.-hr. at $1.50 per ton. It is true that practically all steam plants for power-producing purposes use a relatively cheap grade of fuel. Most of it is slack and can be obtained at the mines for a sum not much exceeding $1 per ton. Adding transportation and handling, the cost usually does not very much exceed $1.50 per ton.. So 6⅔ lbs. of such coal per KW.-hr. is certainly a liberal allowance. Therefore, the final result of 0.5-ct. per KW.-hr. for fuel is, in my opinion, high rather than low, at least it ought to be.

Another feature which plays a very important part in this question is the load factor of the plant in question. The lower the load factor, the smaller will be the number of KW.-hr. turned out of the plant per KW. of machinery installed; also the smaller will be the fuel bill per KW. of machinery installed. The following table indicates in the first column the load factor; in the second column the total number of KW.-hrs. which a plant will put out for each KW.-hr. of maximum load. The third column indicates the cost of the fuel for each KW. of maximum load at 0.5-ct. per KW.-hr. The fourth column gives the figures we are after, and shows the maximum amount of money per KW. that we can afford to put into a water-power plant for the conditions assumed.

Load factor in per cent.	KW.-hr. per year for each KW. of capacity.	Yearly cost of fuel per KW. of capacity at 0.5-ct. per KW.-hr.	Limiting cost per KW. of auxiliary water-power plant.
20	1,750	$8.75	$67.00
30	2,630	13.10	100.00
40	3,500	17.50	135.00
50	4,380	21.90	169.00

The figures in the fourth column are arrived at by considering that the annual fixed charges on the water-power plant must not exceed the annual fuel bill, if the steam plant produced all the power. The fixed charges on the water-power plant are taken at 13% per annum, which is obtained by assuming 5% for interest, 6% for depreciation and 2% for insurance and taxes.

In arriving at the cost of a water-power plant, one should take into consideration not only the hydraulic development and the cost of the machinery but also the cost of transmitting the power from this plant to the market. This last item is very often an important one, since it is usually necessary to make the hydro-electric development at a considerable distance from the market, therefore making the cost of transmission high.

Now let us see what variations in our results will occur when we consider certain known errors that have entered our assumptions. First, we have assumed that the water-driven plant will save all the coal. A reference to the diagram will show that this is much more than can actually be saved unless the stream be developed for minimum flow only. If more than the minimum flow is developed, all the coal that would have been used by the equivalent steam plant could not, of course be saved. To correct for this, the figure in the fourth column of the above table would have to be increased, the amount of this increase would run as high as 33% for the conditions indicated by the cross-hatching in the diagram.

We have also assumed that the apparatus in one plant is entirely duplicated in the other. As a matter of fact, it is necessary to duplicate in the steam plant only such part of the water-power plant as cannot be depended upon to operate continuously. In estimating upon the cost per KW. that we can afford to put in a water-power plant, therefore, the figures given in the preceding discussion should be taken only for that part of the water-power development as is above the minimum flow of the stream. The cost of the minimum flow development will have to stand on its own feet.

As a general result from the above studies, it would seem that where load factors are low, such as is usually the case in the ordinary diversified load plant, the question of developing a water-power plant in a region like that of Ohio is one that demands a very close scrutiny. The cost per KW. of a water-power development is a variable quantity, but it seldom runs below $100 per KW., and sometimes runs to four or more times this figure. The amount spent in a water-power plant can therefore easily exceed the economic limit.

It is evident from the analysis given in the preceding, that the limiting cost of a water-power plant is in direct proportion to the cost of fuel. The results arrived at in the foregoing are based on a fuel cost of 0.5-ct. per KW.-hr. We know of localities in mountainous districts where fuel might cost five times or even ten times this figure, and in such cases the limiting cost that could be put into a water-power plant would be multiplied by the same factor. However, no such districts exist in the States lying in the Mississippi Valley.

It is not the intent of this discussion to discourage all water-power developments. It is simply my intent to point out the fact that when dealing with localities of which the State of Ohio is typical, the question of water-power development is one which should receive a very close study.

A Survey of a Reservoir Made From a Barge.

By H. V. JOSLIN, Jun. Am. Soc. C. E.*

In connection with the preliminary work of increasing the water supply of Norfolk, Va., a method of hydrographic surveying was developed containing one or two novel features which may interest those employed in similar work elsewhere. The chief advantage claimed for this method is the ease and speed with which the work was accomplished under conditions which would have made the work difficult by ordinary methods.

The water supply of Norfolk is obtained from a series of lakes in Princess Anne County, about 7 miles from the city. Little Creek, as the main body of water is called, was once evidently a part of Chesapeake Bay, and is even now connected to it by a narrow inlet. Its southern part has comparatively steep banks and is used as a storage reservoir by the city. A dam 7½ ft. above mean tide water level separates the reservoir from an arm of the bay and shuts out the salt or brackish water. The lake thus formed is extremely irregular and jagged in outline. Add to this the fact that the shores are fringed with reeds, thick timber and thorny vines; and the difficulties of making a survey by the regular method is appreciated.

A survey of the lakes was made in 1901, but at that time the storage capacity was only roughly estimated by multiplying the water area by an average depth. How this average depth had been obtained, there was nothing to show. To report on the present supply required a careful resurvey and an accurate determination of the capacity for both the present water level and for a high water level. The lakes have a drainage area of about 16 sq. mi. and a storage of 2,185,000,000 gals.

The survey was based on a triangulation system having three measured base lines. As a rule only two angles of each triangle were observed; each angle was read but once. In taking sights on triangulation points the magnetic bearing and the approximate stadia distance were always noted, to serve as checks on the observed angles and the computed distances. Although there is a considerable chance for errors in rough work of this kind, the actual difference between the measured and the computed lengths of the two end base lines amounted to but 0.4 ft. in one case and 0.7 ft. in the other. For work of this character this is certainly of sufficient accuracy. There were 145 stations in this net and the total time spent in the field was 8 days.

For filling in the hydrographic and the topographic details, the triangulation system was plotted to a scale of 1 in. = 100 ft., and cut up into sheets containing ⅛ sq. mi. for plane-table use. A plane-table and level were set up on a barge and moved from place to place when necessary. For signals straight saplings with white flags were erected behind each triangulation hub. The position of the plane-table and barge was determined for each setup by solution of the three-point problem.

The barge was an old one that had been used by the department for various other purposes. It was built of 2-in. white pine planks and its dimensions were 17 by 11½ ft. and about 4 ft. deep. While not ideal for this work, it proved quite satisfactory. Were a barge to be built for this purpose, the writer would recommend a slightly larger one having one end pointed and equipped with a rudder. These latter features would considerably lessen the time and labor of propelling the outfit from place to place.

The barge was held in position by four 3½ × 3½-in. stanchions, 12 ft. long, pushed firmly into the soft muddy bottom. The stanchions were fastened to the barge by wrought-iron straps attached to the sides about 3 ft. from the ends. Wedges were driven between the straps and the stanchions and the barge thus held vertically and prevented from rocking. On very windy days ballast was sometimes added to give additional stability. When thus set up no movement of the level bubble was perceptible and work proceeded as on terra firma. Where sand or hard bottom existed another method of holding the barge would doubtless have to be devised.

As soon as the leveler had set up his instrument, he determined the H. I. and the rod reading for the high water line. The rodmen were then directed to the proper elevations on shore to give this rod reading. When the rodman was correctly stationed, the topographer plotted his position on the plane-table sheet. At times the leveler would help by reading off the stadia distance. These points were ordinarily about 25 ft. apart. Opposite to each a reading was also taken to the present water line. As this fluctuated somewhat from day to day a mean of 4.5 ft. below the elevation of the spillway was used as the water line throughout the survey.

TAKING HYDROGRAPHY FROM A BARGE RESTING ON SPUDS.

When the shore line had been located soundings were taken from two row boats. Two men were assigned to each boat. The rod used was a combination of the design of Mr. Arthur Tidd described in Engineering News of Oct. 21, 1909, and the "Florida" rod described on Oct. 28, 1909. On the back of each rod graduations in feet and tenths were made so that the rodman could read the depth of water without turning the face around. After calling out the depth to the leveler, the rodman thrust the rod into the bottom, leaving it erect until the topographer had plotted its position. Soundings were taken about every 75 ft. in each direction. The depth of water was not over 6 ft. in any place. As a rule sights over 600 or 700 ft. were not taken.

The actual time spent on the plane-table work was 24 days. About 13,000 points on shore were plotted, about half of which required level readings also. About 3,500 soundings were made by the method described. The cost of this work was as follows:

Total pay-roll	$333.33
Exp. of fitting out barge	6.00
Transportation	24.00
	$363.33

The general idea of the barge method was the suggestion of Mr. T. B. Dornin, Engineer-in-Charge of the Water Department under whose direction the work was done. The writer was in actual charge of all the field work and acted as transitman on the triangulation work and as topographer on the plane-table work.

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Electric Traction in the Hoosac Tunnel; Boston and Maine R. R.

The work of installing equipment for electric traction in the famous Hoosac Tunnel, near North Adams, Mass., which has been operated under steam since 1875, has now been completed and electric locomotives have been put in regular service. According to press reports, the first regular trains were hauled by the electric locomotives on May 18.

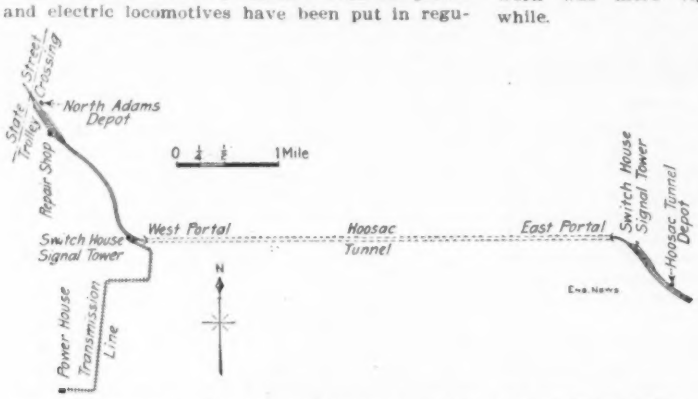

FIG. 1. GENERAL LAYOUT OF HOOSAC TUNNEL, ELECTRIC ZONE.

It will be recalled that this tunnel was proposed as far back as 1825, though for a canal. In 1848, a charter was granted authorizing the construction of The Troy & Greenfield R. R. from the terminus of the Vermont & Massachusetts R. R. at Greenfield, Mass., through the Deerfield and Hoosac Valleys to unite, at the Massachusetts-New York state line, with a road running into Troy, N. Y. The project passed through many trials for the uncertain cost of the tunnel and the long interval before there could be any return on the capital deterred investors. Very little progress was made on the railroad and none on the tunnel up to 1854, when the company finally succeeded in having the State of Massachusetts pledge its credit for $2,000,000.

In 1855 and 1856 contracts were made with E. W. Serrell & Co., and some little work was done on the tunnel. These contracts became inoperative, however, because the railroad company was unable to float its stock. In 1856 a contract was made with H. Haupt & Co., and work was more vigorously prosecuted for a while.

Up to 1861 only 4,250 ft. of tunnel had been constructed and in 1862 the state foreclosed its mortgages on the railroad property and completed the tunnel. The final headings were holed through in November, 1873, and the first engine was run through in 1875, though the first passenger train was delayed until October of that year, and the tunnel was opened for business in July, 1876.

The Hoosac Tunnel is doubled-tracked and has a section about 21 × 26 ft. Its length is 25,031 ft., and the alinement is a tangent. The eastern portal is 768 ft. above sea level and for 2,000 ft. the grade is 0.35%. Then for 10,000 ft. the grade is 0.50%. In the middle there is 250 ft. of level stretch from which the grade descends, at 0.50%, to the western portal 765 ft. above sea level. The mountain pierced has two peaks with a valley between; the maximum height above the tunnel is about 1,800 ft. There were no high temperatures during the construction, and the flow of water was small. English bar timbering was used, the rock being mica schists and gneisses—mostly hard.

The advisability of using electric traction was considered by the Boston & Maine R. R., lessee of the Fitchburg R. R., in 1910, but it was not believed then that the time was ripe. When Mr. C. S. Mellen, President of the New York, New Haven & Hartford R. R. became President of the Boston & Maine also, in the same year, orders were given for the preparation of plans for electric traction, using the single-phase system in use on the New Haven lines. As the New Haven Road at that time was engaged on the electrification of the New York, Westchester & Boston R. R. and the Harlem Branch, an experienced supervising engineer was lacking. Mr. L. B. Stillwell, Past President Am. Inst. E. E. was offered and accepted the position, reporting to the Engineering Department of the New Haven.

Mr. W. S. Murray, Electrical Engineer of the New Haven Road, in a recent paper before the American Institute of Electrical Engineers, stated that general construction in the New Haven had become so fixed that most of the plans could be bodily transferred to the electrification of any trunk line service. To illustrate this, the Hoosac Tunnel construction after the New Haven plans was shown.

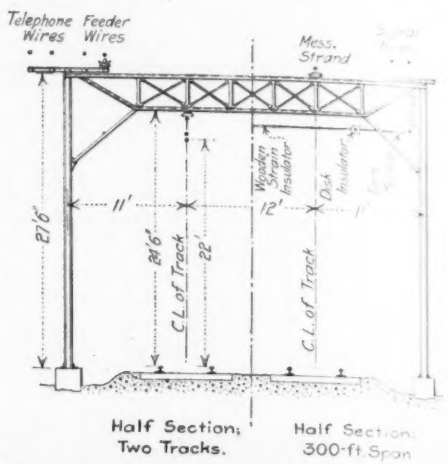

Fig. 3. Bridge Supports for Catenary Overhead Construction; Hoosac Tunnel Approaches.

Some simplification and reduction in the weight

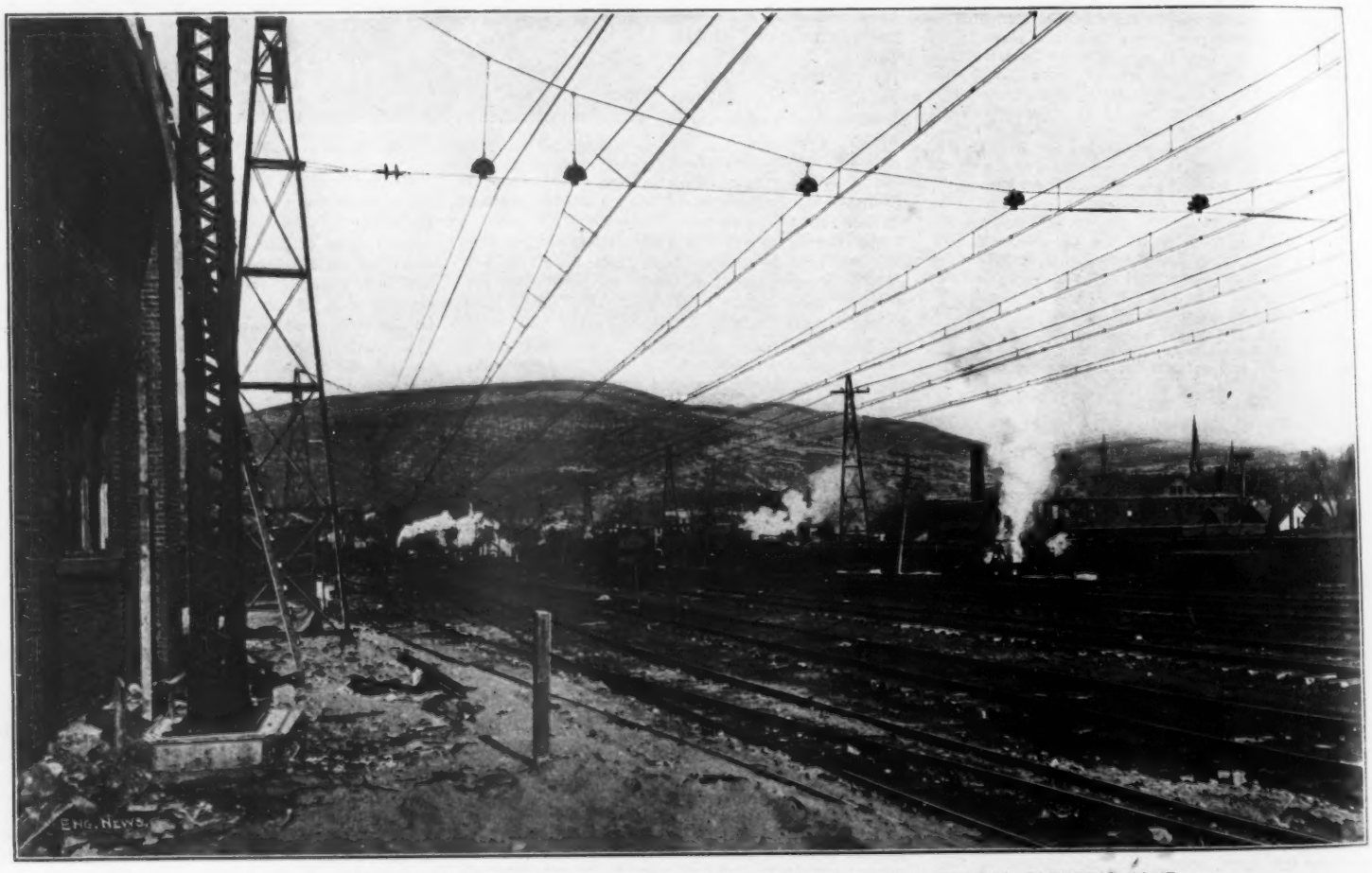

FIG. 2. OVERHEAD CONSTRUCTION IN NORTH ADAMS YARDS; HOOSAC TUNNEL ELECTRIC ZONE.

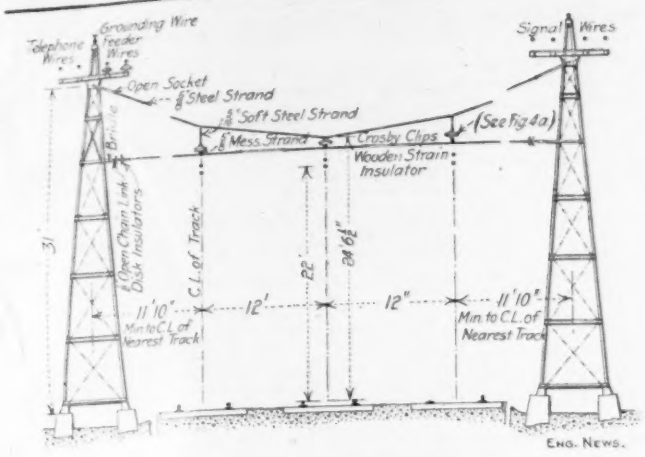

FIG. 4. TOWER AND SPAN WIRE SUPPORTS FOR CATENARY; HOOSAC TUNNEL YARDS.

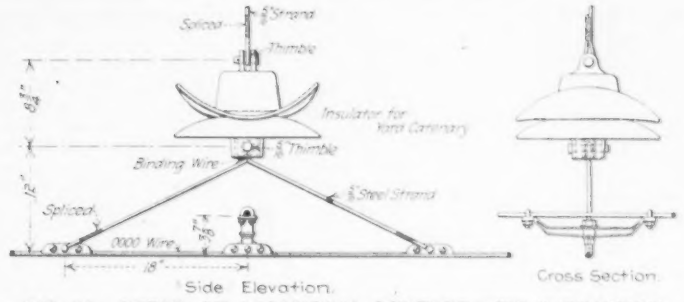

FIG. 4A. DETAIL OF OCCASIONAL CONTACT-WIRE SUSPENSION.

of the locomotives has been secured through freedom from the complication of running over third-rail, direct-current lines, as in entering New York City. Five locomotives have been ordered for the tunnel service; three are intended for freight service and two for passenger trains, but the passenger locomotives will handle the lighter

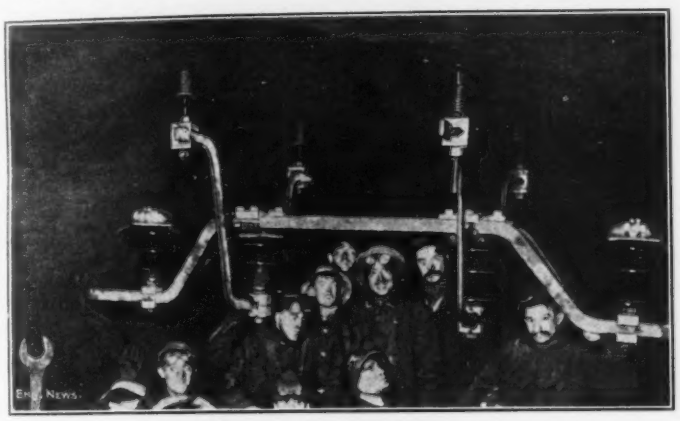

FIG. 5. TYPICAL BRACKET INSTALLED IN HOOSAC TUNNEL.

class of freight trains. The only difference in the two designs is in the gear ratios. Each locomotive weighs approximately 250 tons and is of the general quill-drive type with pony leading and trailing wheels, described in Engineering News, Oct. 7, 1909. The weight is spring supported and there are four main motors of 396 HP., normal hourly rating. These engines were built by the Westinghouse Electric Manufacturing Co., and the Baldwin Locomotive Works.

The use of 11,000 volts in the tunnel, with the small clearances there, brought problems in the location and support of insulators to prevent grounds. The construction worked out is shown in Figs. 5 and 6. Four 150,000-volt insulators are installed on a bracket, suspended from the crown of the tunnel. Two insulators serve the wire for each track, and they are electrically in series between the conductor and the grounded support, giving a combined dielectric strength of 300,000 volts. The outside insulator (Fig. 6) holds the main messenger cable, which is of copper strand, over the track. Two contact wires are hung side by side directly from this messenger cable. This last construction is the regular New Haven plan for limited clearances.

The extra high-potential insulators were used since the cost was only $1 per insulator more and the insurance against breakdown was increased eight times. The tunnel contains 1,000 insulators, so that the extra cost amounted to only $1,000 out of the total cost of $1,200,000 for the entire electrification.

The strain insulators used are those developed by the New Haven Road, shown in Fig. 9. Great progress has been made in the design and construction of such insulators to withstand combined mechanical and electrical stress. When the New Haven's New York terminal electric zone was completed, in 1908, the best insulators that could be secured were rated at 7,000 lbs. and 40,000 volts and cost $27. By steady progress it has been possible to secure such an insulator to stand 110,000 volts and 35,000 lbs. simultaneously, with an ultimate strength of 60,000 lbs. The cost is $7.

The use of a copper messenger cable and the direct running of locomotive pantagraph shoe on the trolley wire are departures from the regular practice, which is seen in the yards at either end. There a ⅝-in. or ¾-in. steel catenary messenger cable (depending on span) supports a No. 0000 copper wire above a No. 0000 "phono" contact wire. All fittings in the tunnel are of bronze for longer life where maintenance is more difficult.

In the tunnel approaches, 110,000-volt insulators have been used at an increased cost of 50 cts. each over the ordinary 40,000-volt type which would have been used ordinarily. This has been done in accordance with the endeavor to raise insulation to a point beyond the chance of breakdown and to eliminate line failures.

In the design of the power house at Zylonite, near North Adams, the plans developed for the Waterbury Station of the New Haven Road were used with slight changes needed to meet local conditions. Two 3,000-HP. steam-turbine generators are used, with provision for a third in case the traffic grows to warrant it. This power house is 2.4 miles from the track catenaries, this distance being needed to utilize an advantageous site.

On Nov. 1, 1910, work on the overhead line construction was started by the contractors, F. T. Ley & Co., of Springfield, Mass. A force of some 500 men were put on throughout the electric zone and the working hours were fixed at

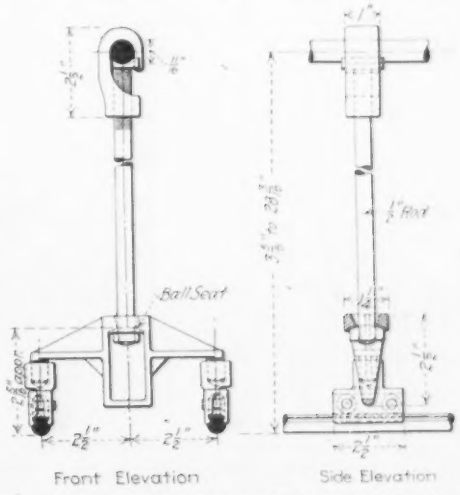

FIG. 6. SUPPORTS FOR 11,000-VOLT CATENARY LINE; HOOSAC TUNNEL.

eight hours for the tunnel crews and ten hours for outside men. About April 12, the outside work was practically completed and then two shifts were put onto the tunnel work.

The difficulties of this work have been great on account of the very heavy traffic which could not be stopped or much delayed. As there were

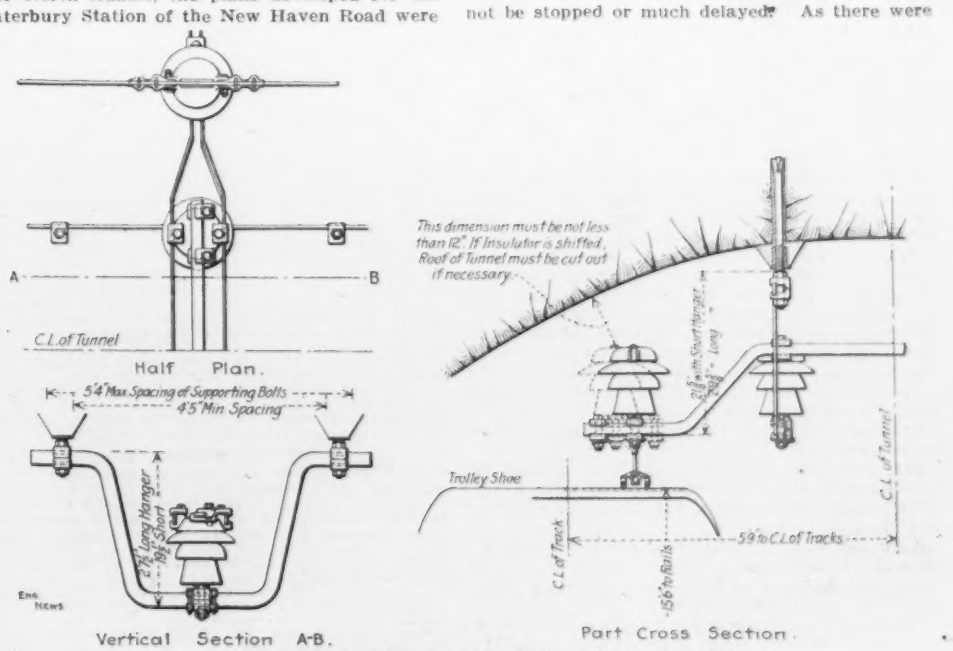

FIG. 7. DOUBLE TROLLEY HANGER; HOOSAC TUNNEL.

one, and sometimes two, work-trains in the tunnel at a time, the regular traffic had to be carried on a single track. The gas and smoke from these regular trains made work difficult and slow, of course, and the conditions were made worse by the necessity of keeping a good head of steam on the work-train engines to develop power for drills, etc. Many men had to be brought to the portals for treatment for partial asphyxiation and a few had to be sent to the North Adams

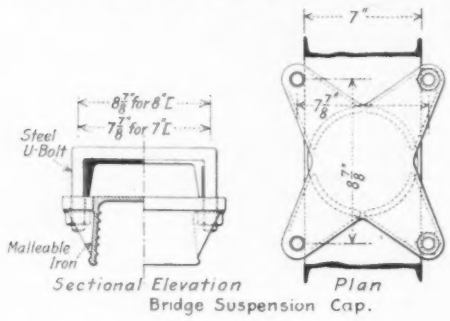

Fig. 8. Insulators for Overhead Construction, Hoosac Tunnel Single-Phase System.

hospital. In all, three lives have been lost in the work.

The electric zone extends from a small tunnel, just west of the North Adams station, to a point just east of the Hoosac Tunnel station. All passenger trains stop at North Adams for the attachment or detachment of the electric locomotives. Freight trains on this side of the tunnel will change at a siding near the west portal. On the east side of the tunnel, passenger trains scheduled to stop at the Hoosac Tunnel station will change engines there. All freight and such passenger trains as are not scheduled to stop at the Hoosac Tunnel station will change to a point between the station and the portal.

THE ELECTRICAL RESISTANCE OF PLAIN CONcrete is the subject of a recent report of a German commission (Deutscher Ausschuss fur Eisenbeton. 6e Cahier. Versuche über den elektrischen widerstand von unbewehrtem beton Ausgeführt in der Material Prufungs-Austalt zu Darmstadt). The report contains the details of the methods of testing, the quality of the mixtures and determinations on electrical resistances of the concrete specimens in air, fresh water, salt water and artificially dried. The principal conclusions of the tests made on mortar blocks 8 × 8 × 36 ins. are as follows:

For a current above 0.1 amp., an increase in current brought about a reduction in resistance.

Resistance in the mortar or concrete decreased as the temperature increased.

The decrease in resistance for the same increase in temperature is the same in gravel concrete as in broken stone concrete but the former has the greater electrical resistance.

Resistance increased with drying and was greater in fresh than in salt water.

Resistance increases as the amount of mixing water or the included water decreases.

The resistance coefficients are relatively small; it is necessary to subject concrete to an artificial drying before it can be considered an insulator.

Concrete Street Paving in Mason City, Iowa.*

By F. P. WILSON.†

During the summer of 1909, Mason City laid 6,000 sq yds. of concrete paving in the down-town district, where it would have a test under the most severe traffic. After standing the severe test of last winter and heavy traffic during the last year, also the cold of this winter it is at this time in as good a condition as the day it was finished. The past season 25,000 sq. yds. were laid, and at this writing contracts have been let for 43,000 sq. yds. which this city expects to have laid this coming summer.

In constructing a first-class concrete pavement, the first requirement is to have strictly first-class materials, secondly, to have a first-class, up-to-date set of plans and specifications; and lastly, a rigid and close following of these specifications in every detail. The following is the detail specifications for Portland cement concrete pavement used in the construction of all concrete paving laid in Mason City, which has proved entirely satisfactory.

Specifications for Concrete Pavement.

PREPARATION OF ROADBED.

All streets, prior to laying any pavement thereon, shall be graded so that the pavements will be at established grade when completed. After excavating to sub-grade, unless the engineer deem the natural ground a proper foundation, excavation shall be continued until solid ground is reached and then refilled to sub-grade with sand, gravel, or broken stone. The contractor shall be required to remove at his own expense all obstructions, such as trees, old blocks, debris, etc.

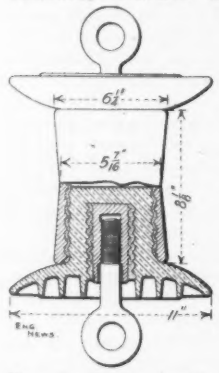

Fig. 9. Strain Insulator for Simultaneous High Mechanical and Electrical Loads; N. Y., N. H., & H. R. R.

EXCAVATION.

All excavated material, gutter stones, planks, macadam, crossing stones, old curb, surplus earth, etc., shall be the property of the city and be deposited by the contractor in such place and in manner as shall be directed by the engineer, the distance not to exceed 3,000 ft. No plowing will be allowed within 3 ins. of the bottom of the foundation.

ROLLING.

When the street shall have been graded and shaped to its proper form, it shall be thoroughly rolled with a 10-ton roller to a thoroughly compact surface. If the ground is wet, sand or gravel is to be put in before rolling. Any depression discovered after this rolling shall be refilled to sub-grade, re-rolled, and this repeated until a road bed, perfect as to grade and form, shall have been made.

TAMPING.

When the use of the roller is impracticable, the foundation must be thoroughly puddled and rammed until compacted to the satisfaction of the engineer.

CONCRETE FOUNDATION.

Upon the roadway thus formed will be laid Portland cement concrete 5 ins. thick, to be made as follows: One part by measure, of Portland cement; two parts by measure, of clean, sharp sand; and five parts by measure, of broken stone.

The sand and cement shall be thoroughly dry on a tight floor and then made into mortar at the proper consistency and thoroughly mixed by hand with hoes or shovels, or with a batch mixer approved by the engineer. Broken stone, thoroughly cleaned of dirt, drenched with water, but containing no loose water in the heap, shall then be added to the mortar in the proper proportion. The concrete will then be turned and mixed until each fragment is thoroughly coated with mortar, a strictly wet mixture being required. The concrete thus mixed shall have such a consistency that when rammed the mass will not shake like jelly, but will, when struck, compact within the area of the face of the hammer without displacing the material latterly.

The concrete thus prepared shall be placed immediately in the work. It shall be spread and thoroughly compacted by ramming until free water appears on the surface, which shall be made smooth and parallel to the surface of the finished pavement. The whole operation of mixing and laying each batch of concrete shall be performed in an expeditious and workmanlike manner and be entirely completed before the cement has begun to set. No retempering of concrete will be permitted, and concrete in which the mortar has begun to set will be rejected.

The thickness of this concrete shall be 5 ins. after same has been compacted. Extreme care should be taken that the sub-grade is kept moist while this concrete is being put in place. No concrete shall be laid when the temperature at any time during the day or night falls below 35° above zero, Fahrenheit.

WEARING SURFACE.

Upon the concrete heretofore specified shall be immediately laid a wearing surface 2 ins. in thickness to be made as follows: One part by measure of Portland cement, two parts by measure of coarse, clean, sharp sand; the sand and cement shall be thoroughly mixed dry on a tight floor and then made into mortar of the proper consistency and thoroughly mixed by hand with hoes or shovels, or with a batch mixer approved by the engineer. The mortar thus mixed will be immediately laid upon the concrete heretofore specified. Before this mortar has begun to set it will be finished off to a smooth surface and corrugated according to the plans.

CORRUGATIONS.

After the wearing surface has been [illegible] shall be corrugated at an angle of [illegible] said corrugations to be 9 ins. apart [illegible] to be ¾-in. in depth and shall be [illegible] tools made for the purpose, and when [illegible] complete the corrugations shall [illegible] rounded upper edge so as to provide a firm and substantial foothold for the horses, no sharp corners to be left. Where the street has a flat grade [illegible] may, if they deem it advisable, order [illegible] and the wearing surface shall be [illegible] float, and before it has completely [illegible] be roughened by brushing with a [illegible] or broom. The curvature and [illegible] pavement shall be made according to [illegible] the same.

MATERIALS USED.

The cement used in the work must [illegible] faction of the engineer, the tests [illegible] mended by the American Society of [illegible] Portland cement shall be protected [illegible] free from exposure to air slacking [illegible] until used.

The sand shall be clean and sharp [illegible]

The stone used for the concrete [illegible] quality of hard limestone, or other [illegible] and shall be broken to such a size [illegible] shall not be larger than will pass through [illegible] and not smaller than a hazel nut [illegible] dust, dirt, loam, or other objectionable [illegible] shall be screened when necessary over a [illegible] to eliminate dust and small particles.

EXPANSION JOINTS.

An expansion joint 1 in. in width [illegible] to the curb on each side of the street [illegible] expansion joint ½-in. in width will be [illegible] across said pavement at right angles to the curbs. Said expansion joints are to be filled with an asphalt paving filler of proper quality and consistency approved by the engineer. It will be applied while heated to a temperature of about 400° F. and shall be so applied that said expansion joints shall be thoroughly filled clear to the top of surface of said pavement. All forms for expansion and contraction joints shall be made of iron or steel in the form of a template, cut to the desired shape of the street according to the plans, and of sufficient strength to resist springing out of shape. All mortar and dirt shall be removed from forms that have been previously used. The forms shall be well staked to the established lines and grades.

CONTRACTION JOINTS.

Contraction joints shall be made entirely through the pavement every 12½ ft. at right angles with the street. The edges of all expansion and contraction joints shall be rounded to a radius of about ½-in. with proper tools. Care shall be taken to obtain a surface free from ridges at expansion or contraction joints, and free from depressions or unevenness in the surface, that will detract from its appearance, or cause water to lie on the pavement. Any section having such inferior surface will be rejected, and shall be rebuilt by contractor at his own expense. Care shall be taken to make the expansion joints in such a manner that they are practically the same width throughout their depth. Extreme care must be exercised in removing templates or divisions used to make expansion or contraction joints; the breaking out of any portion of the pavement, in removing such templates and forms, will not be tolerated, and such damaged portions of the work shall be torn out and replaced in good condition by the contractor at his expense. The contractor shall keep pavement sprinkled for one week after it is laid or longer, if deemed necessary by the engineer. The contractor shall keep the streets barricaded, where pavement has been laid, at least two weeks after completion of the same.

In Mason City the above specifications were followed very closely in every detail.

Twelve thousand barrels of cement were used. From every car ten samples were taken and tested for fineness, tensile strength, and specific gravity; also boiling tests were made.

In the construction of this work a mechanical batch mixer, with a 25-ft. boom, with a traveler on the same was used. After the sub-grade had been thoroughly rolled, the material was distributed along the street, the rock on one side and the sand on the other. The mechanical mixer was set up at the end of the street 25 ft. from the place of beginning. In the first section, 12½ ft. × 30 ft., the concrete was placed. Immediately the wearing surface was placed upon the concrete, not to exceed 20 mins. elapsing between the time the concrete was placed and the wearing surface was put on the same. Then the next section of 12½ × 30 ft. was put in. Then the mixer propelled itself backwards 25 ft. and proceeded as before.

Parallel with the curb and 10 ft. out from the same the wearing surface was cut through into the concrete, these parallel cuts being 10 ft. apart so that the actual blocks of concrete are only 12½ × 10 ft. Some of the streets where the cement paving was laid were very soft and swampy. To obtain a dry and well drained subgrade a trench parallel to the curb on each side of the street, 18 ins. out from the curb and 18 ins. below subgrade, was excavated; a 4-in. tile drain was laid in the same and was connected with the sewers. The earth excavated from these trenches was hauled away and the trenches were refilled with good, clean, hard, burned cinders, making a thorough drainage for the sub-grade.

The contract price for these cement pavements, including excavation, was $1.25 per sq. yd.

The cost to property owners was 5 cts. per sq. yd. in addition to the contract price, to cover the cost of engineering, inspection, advertising, and levying the assessment making a total cost of $1.30 per sq. yd. to the lot owners abutting on said paving.

*Paper read before Iowa Engineering Society, at the 23d annual meeting, Feb. 15-17, 1911, Des Moines, Iowa.
†Mason City, Iowa.

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Definitions as a rule are not of much interest to engineers. They are more concerned with the substance than the wording that describes the substance. However, even the most practical of engineers will admit the universal necessity for specifications, and the fundamentals of a specification are the definitions of the terms that make it up. Where the meaning is ambiguous, these terms must be expressly defined, but general use should in time establish fixed meanings which will be accepted whenever the term is used.

We are reminded of the fact that such general acceptance has not been reached in the field of reinforced concrete by a recent request from a correspondent who wanted to know if a structure formed by plastering mortar on either side of expanded metal or wire lath could properly be called "reinforced concrete." Starting originally merely as a method of making light partitions, this type of construction has been extensively developed along many lines, notably in some fair-sized railway stations in the Middle West and in the large barges on the Panama Canal, and with the improvement of methods for mechanically applying mortar or grout it may be expected to have a much wider application. When completed the units of such a construction consist of a solid wall of concrete mortar with a central stiffening web of steel. Can this reasonably be called "reinforced concrete"?

A comprehensive and simple definition of concrete is "an artificial stone resulting from the hardening of a mixture of hydraulic cement, water and an inert aggregate." This aggregate may be minute sand particles or large pudding stones, but so long as it is completely surrounded by the hardening cement to form an artificial stone the result is concrete. To this massive material is added steel in greater or less degree. In the original combinations of steel and concrete, the steel was used merely to supply the tensile deficiencies of the concrete, so the first tendency was to use the term "reinforced concrete" only when the reinforcement was tensile in character. As the steel began to be used in compression, both on the compressive sides of beams and later as the main section (as in a certain type of column) this definite restriction to a tensile reinforcement became too narrow. So also later there arose the necessity of distinguishing between steel reinforced concrete and concrete-protected steel, such as is used in some types of fire or weather proofing. In short a definition of reinforced concrete should provide that the concrete be figured to take stress and that it be the outside or apparent material.

These provisions are covered by a defin'tion given in this journal some years ago, as follows:

> We understand by that term [i. e., reinforced concrete] any combination of metal embedded in concrete to form a structure so that the two materials assist each other to sustain the stresses imposed.

Under this definition there should be no doubt that the construction questioned by our correspondent is truly "reinforced concrete."

Opinion based on twenty-five years of experience is worth more than printed volumes of theorizing, and so it seems worth while to give conspicuous place to the following words under the heading "Civil Service," from the last annual report (1910) of Mr. J. W. Howard, City Engineer of Savannah, Ga.:

> Having been continuously connected with this department for the past twenty-five years, my opinion formed after careful consideration of the matter is, that most efficient service, and, therefore, the best results, to be obtained from this department can only be secured by the institution of suitable civil service rules governing the appointment of its officers and employees.
>
> Under present conditions every period for the election of the Mayor and Aldermen is a season of fear and doubt on the part of employees as to their tenure of office. This produces a demoralization most harmful to the public service, and even at other times during his term of office the employee knows that upon a change of administration his retention in office does not depend on past faithful service; but, on the contrary, is dependent on the ability of some one seeking his place to oust him by means of political influence.
>
> A man holding office under the above conditions does not have the incentive to that faithful and proper performance of his duties that would obtain did his tenure of office depend on his own ability and integrity. It is not in human nature that it should be so, and the public suffers because the officer or employee cannot put forth his best efforts.

In the minds of many, civil service implies or includes examinations as a means of selecting men or candidates to fill vacancies in the public service. The remarks quoted above relate rather to tenure of service during good behavior, regardless of changes in administration, rather than to the method of selection of candidates. Logically, however, if men are retained on merit they should be selected on merit, and selection on merit involves some method of judging capabilities. Under American conditions it often if not generally appears that the selection on merit principle is most likely to follow if a system of formal examinations and ratings is made compulsory; but if we are correctly informed the name and the practice of civil service originated in England without formal examinations.

Certainly candidates for municipal positions in the English cities are judged by their professional or official records and not by the results of set examinations. But for some classes and grades of municipal service it is required that certificates based on having successfully passed an examination by a private or semi-public organization, like a chemical society or a sanitary association, must be presented as a qualification for candidacy.

The main thing is to substitute fitness for a given position in place of party service or party pull; and once in office, to keep a man there so long as he renders good service and behaves himself.

Three weeks ago we called attention in these columns to the availability of the Ten Mile River to supplement the supply from the Croton water shed and save New York City from the danger of a water famine, and urged that immediate steps be taken to divert this stream into the Croton reservoirs.

We made this suggestion purely in the public interest, believing that the critical situation called for some one with the necessary technical knowledge to sound a note of warning. We made this suggestion also, let us add, after a fairly extensive study of the situation, and a consideration of all available methods of protecting the city from the threatened danger.

Our suggestion has been admirably supported by some of the leading daily journals of New York, but the officials responsible for New York's water supply have been prolific in reasons why the Ten Mile River is an impossible resource for New York City and have devoted their energies to cutting down water consumption and hoping for rain.

We commend both these lines of activity, but have not been seriously impressed with the reasons advanced why the Ten Mile River should not be secured. We showed three weeks ago at much length the technical facts and figures on which our proposal was based. In this issue we show photographs of the Ten Mile River taken last week by a member of the editorial staff of this journal, who made a special visit to examine the proposed location of the pumping station and pipe line.

The photographs show to any doubting Thomas that *the water is there*; and it is a perfectly simple and not expensive engineering proposition to divert its flow into the headwaters of the Croton.

Of course heavy rains *may* come and save New York; and the water department officials by stopping not only the waste of water but such legitimate uses as the flushing of streets and sprinkling of lawns *may* enable New York to worry through the next two or three years without a water famine; but is it worth while to run such a risk?

As a matter of fact it will pay to get the Ten Mile River water. New York ought to have water for use in its parks, for its streets, for all who wish to put it to proper use and are willing to pay for it. The additional supply which might be received from Ten Mile River, if it were all delivered by the city to consumers and paid for at meter rates, would repay the entire cost of obtaining it in years which must pass before the Catskill aqueduct can be completed.

We have fulfilled our duty in pointing out the peril of the city's situation and a quick and easy road to safety. Had those responsible for New York's water supply been wise enough and energetic enough to obtain the Ten Mile supply two or three years ago, New York might to-day be free from anxiety over water scarcity. It is not yet too late to remedy past neglect, *but it soon will be.*

The Introduction of Water Meters and Water and Health Conservation in New York City.

Had New York City followed the advice of Mr. John R. Freeman, given in his report to Comptroller Coler in 1900, and adopted the universal meter system and other well-established waste-preventive measures, New York City might have plenty of water in its reservoirs to-day and full assurance of no serious water shortage before the introduction of the Catskill water-supply.

With characteristic engineering thoroughness, Mr. Freeman made some notable studies of water waste, from which he concluded that of the 115 gals. of water per capita being delivered to Manhattan in 1900 about one-third was used and two-thirds wasted; also (and this showed caution as well as thoroughness) he concluded that some of the waste was incurable, so that while under "ideal conditions," that is, with

> thorough overhauling, with a meter on every tap, with most thorough inspection practicable, and with prompt repairs

the needless waste might be zero; yet with the

> best result that can be reasonably expected without domestic meters ten years hence [or in 1910] starting with thorough overhauling and such subsequent management as can probably be secured from experience of the average large American city

the "total needless waste" would be 34 to 53 gals. per capita each day and the "total consumption" [and waste] 84 to 130 gals.

Complete metering alone, Mr. Freeman esti-

mated, would "probably cure only about half the waste," or bring the combined consumption and waste down to 75 to 100 gals.

Compared with what Mr. Freeman recommended, only a few meters have been set during the past eleven years and but little overhauling and repair of the distribution system, including services and old meters, have been done. The work just indicated, as also district water-waste surveys, has been comparatively scanty and spasmodic. It has been poorly supported, if not actually opposed, by the city government as a whole. There have been exceptions as to time and to men in power, and all the while, we believe, the men in the engineering department, and some of the time their immediate superior laymen officials, would have liked to have done much more than was permitted by the real powers that sometimes govern and too frequently misgovern New York. Perhaps officials and political dictators alike would have gladly done more than the unenlightened public opinion of the city would have sanctioned; but, outside the water engineers, they have given little evidence of such a desire and made little attempt to enlighten the public as to the gravity of water-waste and the feasibility of reducing it with injury to no one.

The crux of the whole matter was sagaciously but perhaps over-mildly or over-delicately stated by Mr. Freeman, in his 1900 report, as follows:

> The real difficulties about saving the water waste, rest in human nature and are questions of getting the voters to understand the truth of the matter, questions of public sentiment, politics and good government. From studies in the result of efforts at waste prevention in other large cities and from inquiry made among well-informed men as to the present sentiments of the New York public regarding domestic meters, I am led to believe that for the immediate future these difficulties are insurmountable, and that the hope of a cure for any large part of the waste very remote. * * * The real obstacles to reform are grounded in human nature and not in hydraulic engineering.

That this was a correct diagnosis of the situation in 1900 no one will dispute. Events have also shown that what was true in 1900 has continued to be substantially true ever since—that is, in New York City, and in the absence of earnest, continued and well-directed official efforts to create an enlightened public opinion for thoroughgoing waste-preventive measures. But the New York officials have not done all that was readily possible without appealing to or creating adverse public opinion. Had they wished, probably they might have done everything advised by Mr. Freeman short of installing meters on every tap, and it is probable that meter installation and certain that the inspection and repair of existing meters might have been far better carried on than appears to have been the case.

In the eleven years since Mr. Freeman wrote his report much has been done outside New York City to extend the universal meter system. The best-known example of meter extension is afforded by Cleveland. High hopes were raised of the adoption of modern water-waste preventive measures in New York City when Mr. Edward W. Bemis, formerly Superintendent of Water Works of Cleveland, O., was brought to New York early in 1910 and made Deputy Water Commissioner. Had Mr. Bemis been backed by the officials of New York City as heartily and effectively as he was by those of Cleveland, there is little doubt but what thoroughgoing waste-restrictive measures would now be under way in this city; at least in so far as State legislation permits. It is also probable that legislation might have been secured which would have removed all obstacles to the introduction of meters in New York as rapidly as the experienced judgment of Mr. Bemis would seem to warrant. Furthermore, it is likely that, had Mr. Bemis had a free hand and been continued in office, he would by this time have done much to enlighten the New York public, as he did the Cleveland public, as to the real objects and advantages of the use of water meters.

We do not mean to say that with the forced resignation of Mr. Bemis from the New York Department of Water Supply waste-restrictive measures have been stopped. In fact, a letter from Mr. I. M. de Varona, M. Am. Soc. C. E., Chief Engineer of the Department of Water Supply, published in our issue of Feb. 16, 1911, gives warrant for the belief that work has been continued on much the same lines since the retirement of Mr. Bemis.

We are pleased to note that since the imminent danger of serious water shortage at last became apparent to the officials, an appropriation of $100,000 has been made for the employment of over 100 inspectors and clerks to conduct an enlarged waste-inspection service. This should result in an immediate material reduction in water waste. We trust that it will be possible to reinforce the house-to-house inspection with comprehensive studies of waste by districts.

While the extensive house-to-house inspection, which we understand is proposed, is comparatively necessary under existing circumstances, every experienced water-works man well knows that at best house-to-house inspection is but a temporary preventive of waste, and that even though it be repeated at frequent intervals large amounts of waste will result between inspections. In fact, even a daily inspection would hardly serve to prevent extensive water waste. The best water-waste inspector is a water meter, because it is "always on the job."

While the complete metering of so large a city as New York would take a number of years, experience shows that in a practically unmetered city, such as New York, the judicious extension of the meter system may bring any material reduction in water waste in a short time, which will increase with the steady addition of meters.

It is sincerely to be hoped that the New York Department of Water Supply will receive such official backing in the way of appropriations and general support and encouragement as will enable it to make speedy material additions to the relatively small number of water meters now in service. When reservoirs are being rapidly depleted and no rain is in sight, even slight immediate reductions of water waste are of great value. With the possibilities of a shortage of water from the Croton drainage area for several years to come, there is a possibility of doing much to prevent serious water shortage by an installation of water meters during the next two or three years.

Even after the introduction of the Catskill water, it will be highly desirable to have a large percentage, if not all, of the water consumers in the city metered. The population is increasing by leaps and bounds, and it does not take a long look ahead to see a possible shortage even in the Catskill supply. It should be remembered that the additional supply from the Croton drainage area made possible by the building of the new aqueduct and additional reservoirs was at times dangerously near exhaustion, long before the construction of the Catskill works was begun. Besides this, account should be taken of the fact that the only fair way to sell water is by meter measurement, and particular attention should be given to the desirability of establishing filtration works for both the Croton and the Catskill supplies at the earliest possible date.

As to meters being the only fair means of apportioning the increasingly heavy cost of municipal water-supplies, we quote, a few lines further on, two editorial paragraphs from "The Sun" (New York). These paragraphs were printed alongside a letter from Mr. Clemens Herschel, M. Am. Soc. C. E., citing some of the many arguments in favor of installing meters in New York. "The Sun" said (italics are Mr. Herschel's):

WATER SPENDTHRIFTS.

> Should the measures already adopted by the city authorities to reduce the waste of water in Manhattan and The Bronx not bring the total consumed down to reasonable figures, meters may be installed throughout the two boroughs. The mere *threat* of this should result in the immediate repair of all the leaky fixtures now uselessly draining the reservoirs and giving to the overworked word "famine" a significance it has never had hereabouts.
>
> It is not the possibility of being obliged for a year or two to pay for all the water taken from the mains that would *frighten* the proprietors of dripping faucets and unsealable tanks, but the fact that were meters once adopted by the Department of Water Supply would never be removed. For years it has been cheaper to let plumbing go to pieces and water run than to keep packed taps and tanks tight. There has been more water than could be used, and the failure of any plan that would enforce ordinary prudence in its use has been regarded as an impossible task. Were the system of charging for the water once put into operation its virtues as a revenue producer would so endear it to the managers of the finances that it would never be abandoned, and the real estate owners of New York county would be obliged *to pay for what they got*.

Mr. Herschel appears to think that the foregoing remarks are in opposition to meters. Perhaps they were so intended, but what of the editorial quoted, it strikes us as being one of the strongest arguments in favor of water meters we have ever seen. Even so, it will bear reinforcement by the following comments sent to this journal by Mr. Herschel:

> Water meters are merely instruments for enabling each water consumer to pay an equitable and proper proportion of the total cost of supplying them with water. There is no "threat" involved in the using of a meter, except to a wrong doer. The placing of meters should be welcomed by all good citizens.
>
> In New York it has always been opposed by owners of leased premises, especially of tenement houses, and possibly also of apartment houses, on the plea that the owners of such houses have no control of the amounts of water wasted on their premises by their tenants.
>
> But the cure is a simple and a homeopathic one, to put in more meters, until each one's waste is brought home to him.

Before we close, we feel constrained to mention one other phase of the meter question. Many people who have never looked far into the subject honestly believe that water meters on dwellings unfavorably affect the public health. Dismissing as too absurd for serious discussion such statements as that meters are a lurking place for disease germs or that they have any deleterious effect upon the quality of the water passing through them, brief consideration may be given to the only seemingly plausible, though really fallacious, reason against meters alleged to be based on health-considerations. And our only reason for reverting to this well-worn and often disproved argument is that no less eminent a personage than Mayor Gaynor is reported as having recently expressed himself as against metering private consumers in New York City because, through a desire to save expense, the less well-to-do would not use water enough for cleanliness and health.

The household water bills of many thousands of metered consumers in scores of American cities, both large and small, show that meters do not keep people from using water in quantities more than ample for purposes of both health and convenience. In fact, the almost universal "minimum charge" to any and all metered water consumers covers a quantity of water sufficient for the needs of an ordinary household. Moreover, wherever more than one plumbing fixture is used, the ordinary schedule or fixture rate is generally more than the minimum meter rate, thus permitting an alternative between a still more liberal use of water than is covered by the minimum rate and an actual saving on water bills.

This fact deserves emphasis: *The object of water meters is not to curtail USE but to reduce WASTE of water, and to apportion water charges justly between water consumers.* While this is well known to engineers and also to experienced water-works officials who are not engineers, it is not yet understood by the general public or by city officials who have not yet made a study of water-works administration.

Those who talk about water meters being prejudical to health should bear in mind that in helping to reduce water-waste to a minimum they contribute materially to the financial possibilities of securing a more healthful water-supply, free from possible disease germs. If any of our cities are so fortunate as to have a water-supply beyond improvement as to quality, there yet remain many other sanitary betterments to be carried out which would return high percentages as public-health investments, whereas water-waste does no one any good.

There are some who believe that New York should have built works to purify the Croton supply long before this and that the Catskill supply should be purified when introduced. Careful

studies and more or less complete plans for purifying the water from each source have already been made, and wisely. But the real question of the hour is not the purification of existing or of prospective supplies, nor the effect of water meters on health, but what can be done to conserve and to supplement the existing sources of supply during the present period of depleted storage in the Croton drainage area and danger of water famine until the Catskill water can be obtained. To this end the extension and perfection of the meter system, house-to-house and district inspection, and all other means of waste restriction should be pursued unremittingly: first as emergency measures to avert a possible water famine, and, second, as a part of a rational permanent policy in the interest of economy, a fair distribution of water charges and the conservation of both water and health—our two greatest national resources.

The Electrolytic Disintegration of a Reinforced-Concrete Building.

The vague general apprehensions of many engineers about the integrity of steel buried in concrete, which we have previously voiced (Eng. News, Dec. 24, 1908, p. 718), have become definitely realized in the case of the packing house described by Mr. Harold P. Brown elsewhere in this issue. Now that a specific instance of these suspected troubles has appeared, and a logical, satisfactory explanation of the cause in this case is found in a not-at-all unique combination of local conditions, many readers will exclaim, "Why, this trouble should have been expected!" Before thus accusing the owners, the builders or the designers of the building, it should be remembered that the dangers of electrolytic damage of reinforced concrete were noted by the late A. A. Knudson in 1907—not until after the erection of the particular building now in trouble.

In this packing house, the ordinary operations carried on cause the air to become heavily laden with acid-charged vapors which condense on the walls and ceilings and on any cold metal exposed. The electric-lighting circuits carry direct current at 110 volts and are run in iron conduits, unconcealed and held in place with bolts and sockets bearing on the reinforcing steel. What happened we may picture thus: the condensed vapors soaked the concrete and collected on and inside the conduits; the insulation of a negative wire or connection at one point and of a positive wire at some other point broke down, with the result that leakage current flowed from a negative wire to the reinforcement, through the concrete to other reinforcement and then to the grounded positive wire, with resultant corrosion and disintegration wherever the current left the steel for the concrete. This action in the five years of the building's life has been insidious and cumulative, and the damage now appears serious and widespread.

In spite of the evident breakdown of the structural units in the building in question its structural inefficiency to-day is not at all marked. For some reason, possibly because of the greater quantity of rods in the middle of the beams, the cracking is more pronounced there, and the total destruction of bonds extends apparently for only about 30% of the total span on each side of the center. There is, accordingly, a considerable length of beam near the supports where the bond is not visibly affected. This area, the area of greatest bonding stress, is sufficient to prevent the rods pulling from their grips to the total destruction of the beams and of the building. What is more, the worst-affected beams in the building when tested did not show excessive deflection under a load 25% in excess of the designed load. Unfortunately, the details of the reinforcement are not as clear as they might be, but the proved strength of the tested beams is evidence of integrity of material and possibly of a surplus of original strength.

Because this building has not completely failed, we should not forget the insidious dangers of electrolytic corrosion of the steel, and consequent decomposition of the concrete in a reinforced-concrete structure under unfavorable conditions which we may recognize if warned. From the very nature of the structural failure—a gradual oxidation of the steel rods and a demand of the oxide for more room until the surrounding concrete cannot withstand the bursting stress imposed—there is no structural warning of impending failure until cracks in the concrete show the necessary bond between the two materials to be broken. By that time the chances are that many other parts of the structure are affected by the electrolytic action and that they are at or near the point of incipient cracking, which may develop under excess load or effect of time and slow chemical changes. This absence of any warning from the building itself makes all the more necessary the primary precautions against the occurrence of any electrolytic action in such a building. It makes highly advisable a careful scrutiny of other reinforced-concrete structures to see if the unfavorable conditions may exist, even in the absence of any evidence of disintegration itself.

As a result of the publication of these details about the packing house in question, there will be, doubtless, no small anxiety in the minds of owners and designers of reinforced-concrete structures as to the presence or absence of electrolytic corrosion in their own properties. A careful scrutiny by every designer and owner is to be generally recommended, but there is no occasion for a panic or a campaign against the use of reinforced concrete, any more than against the electric light or street railway.

Fortunately, since the warning was first sounded several years ago, considerable practical information has been accumulated on these electrolytic actions, so that we can recognize at least many of the conditions which must be observed to prevent such damage. The best remedies lie in prevention before damage, rather than in repairs afterwards. In our previous discussions on this subject, we have pointed out that danger lay in permitting leakage currents to reach the concrete. The remedies then suggested—the removal of possible electrical contacts and isolation of ground waters—suggest the conditions which have been found to exist in the building under discussion. To-day, perhaps, we should re-express the same ideas by saying that possibility of random voltages is to be eliminated and the effect of all sorts of moisture in and about a building is to be carefully analyzed. Of course, much of this work demands the employment of a skilled electrical engineer, for we should no more expect a structural designer to be able to scrutinize the electrical conditions than a layman would expect a horse-doctor successfully to treat nervous prostration.

In the case under discussion, there was a concurrence of unfavorable conditions, such as (1) the use of direct-current circuits in unsealed conduits fastened to the reinforcing steel, and (2) the excessive condensation of acid-laden vapors which penetrated the conduits. This time the much-abused electric-railway current was absolved from responsibility. In other cases, however, it is not to be assumed that there cannot be stray currents from some railway track.

Where such electrical troubles exist as were found in this packing house, it was only to have been expected that there should have been also noticeable troubles from dim lamps and blown fuses. Inquiry shows that such troubles did exist, but their significance was not realized in the absence of certain switchboard indications of grounded circuits. Had the designer understood that the extreme moisture conditions were to exist, a water-tight marine installation of the electric circuits, not hung from the reinforcement, should have been provided, and the probability is that the present trouble would not have taken place. The possibilities of better ventilation also seem to have been neglected by the owners after occupation.

So far as present knowledge and expectation go, where chance contacts with alternating-current voltages are possible, the danger in similar buildings lies rather in damage to the alternating-current system than to the reinforced-concrete structure, as shown in the typical experiments described in this issue. Repeatedly, alternating current has been passed through reinforced-concrete specimens for many weeks without evidence of corrosion or disintegration, the current strength being ten times or more that value which with direct current would disrupt the concrete in a week. Nevertheless, on account of the incompleteness of our knowledge of all of these actions, good engineering practice would dictate that chance random contacts of even alternating-current circuits should be prevented.

The question comes to mind, of course, if the trouble was in one way due to condensed vapors, why not prevent the entrance of the vapors into the concrete, as well as into the electric circuit. That undoubtedly could profitably have been done in this case. It is necessary to note, in this connection, that it would not have been sufficient to use what is called an "impervious" concrete mixture for the building or for a plaster coating. An examination of the typical experiments discussed elsewhere in this issue shows that the electrical conductivity of neat-cement specimens, dry and wet, decreases in approximately the same ratio as does the resistance of dry and wet concrete specimens generally; that is, in spite of the small percentage of voids which prevents the appreciable seepage of water through, sufficient moisture permeates the mass of an "impervious" mixture to make it a good conductor, compared with its condition dried. Where condensation of vapors on walls and ceilings has to be contended with, and where such condensation may lead to the damage shown in this particular case, it is necessary to go to a strictly waterproof covering, that is, a water-repellent membrane—a paint or other coating. It is necessary, also, periodically to repaint or otherwise renew the repellent surface.

LETTERS TO THE EDITOR.

Photography for the Engineer.

Sir: The writer has read with much interest the article by Mr. S. L. Jeffrey dealing with "Photography for the Engineer," in your issue of April 6, and the letter of Mr. Durham in your issue of May 11, and has filed both of these interesting papers for reference.

It appears, however, to be the fact that both papers leave something to be desired, because they neglect to define exactly what they have in view. Mr. Durham is dealing with photography chiefly as an incidental addition to an engineer's regular duties, while Mr. Jeffrey evidently means it to be a regular, or systematic record of work in progress. For municipal engineers, for chief engineers of operating railroads, and for many of the large corporations, an outfit such as Mr. Jeffrey suggests is not at all impracticable; for the mere incidental use of the field engineer on construction, it would, of course, be entirely impracticable.

There is no record so reliable, so unquestionable as a series of photographs taken at regular intervals, or at regular intervals supplemented by views on special occasions, provided these photographs bear serial numbers and dates on the negatives, and are filed systematically. This record can readily be secured, as the incidental work of an engineer with a very simple outfit, or on a much more elaborate scale by regularly assigning the photographic work to an employee or by employing an official photographer.

A number of the large corporations do appoint a local photographer to such duties and when the right kind of man is available in this capacity, the writer believes it to be an excellent thing to do, with a higher general average of excellence in the photographic records.

The outfit used by one of the most efficient of these official photographers is worth noting. He carries an 8 × 10 camera with long bellows, equipped with a convertible Protar lens. With such lens he can use either the front combination, the rear combination or the doublet, with corresponding differences in the sizes of the pictures as shown on the ground glass. With a little adjustment of position therefore, he can nearly always "cover the plate" with the view he wishes to take. He supplements this with an extreme wide-angle lens, which will "take anything."

This outfit, with its tripod, its complement of plates and a flash-light equipment when properly packed up for transportation, weighs 40 or 50 lbs. and costs $400 to $500. It is almost exactly the same equipment as that of the Eastman Cycle Graphic camera, size 8 × 10, supplemented by the wide-angle lens.

The photographs which this official photographer returns are all 8 × 10 ins. in size, are all mounted on linen with a 1¼-in. margin for binding and every pic-

ture bears a serial number and a date. All views are taken with the 10-in. dimension horizontal.

For the incidental use of an engineer, the writer quite agrees with Mr. Durham in approving the 3-A, special kodak. An engineer in the field should use films, and the 3-A size is as large as a film camera should be. This camera complete, with a case and tripod, and supplemented with a tank-developer outfit, film album, printing frames, etc., would cost about $80. As the user becomes skillful, it will yield a very high average of results.

The tank-developer outfit is so simple and so good that there is no reason why a field engineer should not use it, and also no reason why he should not make blue prints at least from his negatives as fast as he makes them. Whenever the engineer can afford to buy a 3-A Graflex camera with Protar Lens, he should do so. This camera only weighs about 4 lbs. and will, of course, record fewer failures, than the other camera.

In all photography by engineers there are three rules that must be observed if good results are to be assured. These are as follows:

(1) Whatever camera you buy be sure to get a suitable tripod with it, and use the camera with the tripod whenever it is practicable to do so.
(2) Always use the smallest aperture (with corresponding increase in time) that the circumstances will permit.
(3) Always time your exposures to some regular schedule and do not vary from this schedule until experience shows it to be desirable.

The accompanying exposure table gives excellent general results.

The directions stated above may seem to indicate that the writer agrees with Mr. Jeffrey that a fast lens is not desirable. On the contrary however, an engineer's camera should be equipped with the fastest lens it can use. The speed is there when it is needed, and there are many occasions when these big fast lenses which are able to give good definition when wide open, are invaluable. But, as indicated above, the small aperture and relatively slow speed should always be used when practicable, because the smaller the aperture the sharper the definition and the greater the depth of the focus. The writer uses extra fast films so as to be able to take snap shots with smaller apertures.

A regular series of photographs has been mentioned above as an invaluable record of facts. It is extremely valuable in case of disputes. It is good evidence in court, and it is much better as an exhibit, in a court case, than a plan. For instance, suppose there was a dispute between the engineer and the contractor over the classification of material in a cut. Is it not highly probable that the photographs would settle the question?

Yours truly,
F. H. Lewis, M. Am. Soc. C. E.
Consulting Engineer, Birmingham, Ala., May 16, 1911.

EXPOSURE TABLES (BAUSCH & LOMB OPTICAL CO., FROM BRITISH JOURNAL PHOTOGRAPHIC ALMANAC).

The following table, based on that of Burton, gives a rough idea of the exposures for various subjects and diaphragms under the following conditions: (a) Best lighting; midday sunshine in May, June and July; (b) With the most rapid commercial plates. See below for factors applying to other conditions.

F No.	Average subject with objects in foreground. Street scenes. Out-door figure studies.	Landscapes with light foreground, lake, river and beach scenes.	Sea, clouds and sky.	Subjects with extra heavy foreground e.g. dark trees, doorways, groups.	Under trees, woods, avenues, glades, etc.	Portrait in average well lighted room.
F:4	1/250	1/500	.....	1/125	1/30	1/8
F:4.5	1/200	1/400	.....	1/100	1/15	1/7
F:5.6	1/125	1/250	.....	1/64	1/15	1/4
F:6.3	1/100	1/200	1/1000	1/50	1/8	1/3
F:7	1/80	1/125	1/800	1/45	1/7	2/5
F:8	1/64	1/100	1/600	1/30	1/5	1/2
F:11	1/30	1/60	1/300	1/15	1/2	1
F:16	1/15	1/30	1/150	1/8	1	2
F:22	1/8	1/15	1/80	1/4	2	4
F:32	1/4	1/8	1/40	1/2	4	8
F:45	1/2	1/4	1/20	1	8	16
F:64	1	1/2	1/10	2	16	30

In weather other than bright sunshine the above exposures are multiplied as follows:
(Bright diffused light, the sun behind a cloud) × 1½. (Light clouds over whole sky, but light able to cast a visible shadow) × 2. (Heavy clouds over whole sky, absence of distinct shadows) × 3. (Very dull, whole sky covered by still heavier clouds) × 4 to 5.

Sir: I have been much interested in some of the suggestions in recent articles regarding the use of the camera by engineers. The camera is a fine servant but the tendency of too many is to become slaves of the fad. Photography will consume all of one's time unless much of the detail is left to others. My practice is to leave all of it to others except making the exposure. My camera is a 3¼ × 4¼-in. roll-film pocket camera, with a good lens and scale focus. I have tried larger plate cameras, but found that their disadvantages far outweighed their advantages. My pictures are made for notes; some have never been printed as the negative in the file is sufficient. I endeavor to reduce my photographic work to a minimum and if it was possible to get another to see the features I desired I would cheerfully send the camera out by proxy. Printing and developing, except in emergencies, can be obtained very cheaply and quickly. I therefore look on this part of the process as a waste of time. In fact, if I had to devote myself to these portions of the work, I would stop taking photographs. I have found the camera which I use plenty large enough, as the prints can be enlarged if necessary. The negatives, filed in a card index drawer, do not break in moving around and are light. As I am not taking photographs for the fun I can get out of it, I would use a smaller and lighter camera were I to do it over again. I would like one I could carry in a pocket without its forever making me aware that I had it.

Very truly yours,
A. D. Williams.
4106 Perkins Ave., Cleveland, Ohio, May 21, 1911.

Locomotive Truck Swing; Exact Formulas.

Sir: Engineering News of May 11, 1911, gives the derivation of the formulas for the correct length of radius-bar, and for the approximate swing of locomotive trucks on curves. It may prove interesting to the readers of this paper to examine the derivations of formulas for the *exact* swing of the four-wheeled and pony trucks.

The above-mentioned approximate formula for truck swing is sufficiently accurate for ordinary cases, but when dealing with very sharp curves, such as are to be found in logging camps, quarries, etc., the error becomes very conspicuous. In such cases it is necessary to employ a more exact method. The following methods will prove correct for all cases:

SWING OF FOUR-WHEELED TRUCK.—Let:
A = length of rigid wheel-base.
B = distance from center of front drivers to center-pin of truck when engine is on a straight track.
S = one-half the total swing of the truck.
R = radius of curve of track,
all dimensions to be expressed in terms of the same denomination.

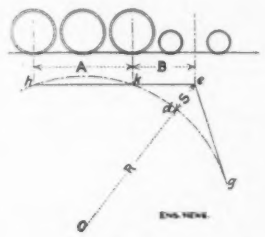


Fig. 1.

Since a four-wheeled truck swings directly toward the center of the curve, the line $d\ c$, Fig. 1, will represent the amount of swing of the truck from its central position. Draw tangent $e\ g$.

The tangent $e\ g$ is a mean proportional between the whole secant $h\ e$ and the portion $k\ e$ without the circle, also between $(o\ e + R)$ and $d\ e$.

$$\overline{e\ g}^2 = h\ e \times k\ e = (2R + d\ e) \times d\ e, \text{ or}$$
$$(A + B)\ B = (2R + S)\ S$$
$$S^2 + 2\ R\ S = (A + B)\ B$$

Completing the quadratic equation

$$S^2 + 2\ R\ S + R^2 = (A + B)\ B + R^2$$
$$S + R = \sqrt{R^2 + B\ (A + B)}$$
$$S = \sqrt{R^2 + B\ (A + B)} - R$$

SWING OF PONY TRUCK.—Let:
A = length of rigid wheel-base.
B = distance from center of front drivers to center pin of truck when engine is on straight track.
a = distance from center of front drivers to radius-bar pin.
b = length of radius bar.
S = one-half the total swing of truck,
all dimensions to be expressed in terms of the same denomination.

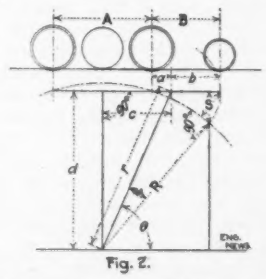


Fig. 2.

The following proof is applicable only to the case where the length of the radius bar b corresponds to the value given by the expression $b = \frac{(A+B)\ B}{A+2\ B}$. Referring to Fig. 2,

$$d = \tfrac{1}{2}\sqrt{4\ R^2 - A^2} \text{ and } c = \frac{A}{2} + a$$

By trigonometry

$$\sin(\theta - \omega) = \sin\theta\cos\omega - \cos\theta\sin\omega$$
$$\text{or, } \frac{d - S}{R} = \frac{d}{r} \times \frac{R}{r} - \frac{c}{r} \times \frac{b}{r}$$
$$\text{or, } \frac{d - S}{R} = \frac{d\ R - c\ b}{r^2}$$
$$\text{or, } d\ r^2 - S\ r^2 = d\ R^2 - b c\ R$$
$$\text{or, } S = \frac{d\ r^2 - d\ R^2 + b c\ R}{r^2}$$
$$\text{or, } S = \frac{d\ (r^2 - R^2) + b c\ R}{r^2}$$

but $r^2 - R^2 = b^2$ and
$r^2 = b^2 + R^2$

$$S = \frac{d\ b^2 + b c\ R}{b^2 + R^2}$$

S may be taken either as the lateral displ[illegible] of the center of the truck with reference to the [illegible] line of engine, or as the displacement of the cen[illegible] with reference to the center line of truck, as indica[illegible] the two arrows in Fig. 2.

H. C. [illegible]
Baldwin Locomotive Works, Philadelphia, May 15, 1911.

The Peril of Water Famine in New York; Further Approval of the Ten Mile River Source.

Sir: I congratulate you upon your very [illegible] practical suggestion for a temporary supply of water for New York City from Ten Mile River, and also upon your editorial of last week concerning the law of waters crossing State boundaries, in which you point out the terrible loss suffered by the City of New York when it allowed itself to be frightened away from that logical source of supply, by all means the best not only for temporary, but for permanent use.

What the City needs now in relation to the temporary supply is exactly what it needed when that wrong decision was reached, namely, a resolute action and faith that the legal profession and the courts can find in the common law and in equity a way to meet an urgent public necessity.

The City is now drifting impotently toward a calamity, mere insurance against which justifies a very large expenditure, even should the proposed temporary works never be used at all. The Croton records show that out of 21 years, in the past, during which the average [illegible] flow of the stream has fallen below [illegible] day, it has recovered only three times [illegible] tember, once in October, four times in [illegible] times in December, seven times in January and twice in February or later. It will be seen, therefore, that the chances are about one in seven that relief will be had by Sept. 15, and there is an even chance that we will not get relief until December. Four inches of rain each month during the next three months, would all evaporate. The earth would absorb about six inches more, consequently we must have eighteen inches before we can hope for any recovery in the depleted reservoirs. It is plain that we have an extremely small chance of getting it. *I cannot think that those responsible have an adequate conception of what it would mean for the City to be out of water even one week.*

Having assisted the late William E. Worthen when he investigated the Ten Mile River for the Aqueduct Commission, I can appreciate the excellence of your suggestion from an engineering standpoint. I am also in the main with your contentions as to the legal aspects; and without claiming to be an authority on these questions, I believe that the broader aspects may be advantageously discussed by laymen and especially by engineers who are brought so frequently into contact with the laws affecting riparian rights.

There is some force perhaps, in your laying blame upon too close adherence to ancient laws of riparian rights, but the main difficulties arise from quite different causes. Most intolerable of all are the county line barriers within the State of New York, erected by statute. In the name of common sense and common humanity it should be possible to repeal these, but if not repealed, they are even more insurmountable than the interstate difficulties.

Another kind of barrier is that created by statute in the State of New Jersey, not in the interest of, but in contravention of ordinary constitutional and common law property rights. Do not think that these are inspired by any legitimate property interest or that they are in response to any intelligent popular demand. Citizens of that State who know anything about the subject beyond what they have been told by two or three rather yellow journals, know that this is not a conservation measure in the public interest, but is inspired by a few who believe it will serve their own ambitions or still more sordid personal interests.

The third class of legal obstacles to which your remarks unquestionably do refer, is, in my opinion, the

easiest to dispose of. In the Byram River case, although the riparian owners in Connecticut might have been technically entitled to an injunction, the court refused it and the owners were compelled to accept compensation. Many other instances in which the courts have refused to enjoin the operation of water-works and sewers are well known.

The constitutional provision that private property shall not be taken for public use without compensation, is extremely wise and just. Even a logical socialist would not ask to have some such property taken unless all is to be taken by the public. Neither would the English rule as to impounding flood waters help much. Many power plants are profitably using as much as 80 or 90% of the average flow of fluctuating streams. No City would be willing to allow compensation water to run from its reservoirs even to the extent of half the average flow. It is better business to condemn and pay for the riparian rights and the right of eminent domain is ample to guard against unreasonable use of such property rights in my opinion. Such abuses as have grown up have not arisen from the ancient principles and rules, but from misapplication of the same.

At times our courts may be too much bound by precedent, the recent trust decisions of the Supreme Court whether right or wrong, are sufficient to show that the law, in the light of modern experience, may be invoked against both unreasonable statutes and precedents. New conditions still make new law. Common law, originally the offspring of Saxon customs, has room in England immense possibilities for development through a wide range of evolution, and aided by equity, has in it much more virility and adaptability than statute law.

A crime of the individual against the State was recognized to be possible at the very dawn of English law and out of this germ grew potent possibilities, in the common law, to cure all such misuse of private property interests as the lawyers seem to have feared might occur in the Ten Mile River matter, and probably even such abuses as the Sherman statute law has been impotent to remedy in the matter of trusts and monopolies.

Granted a public necessity, the State lines should be no barrier to the application of common law and equity principles and I cannot believe that they are. Long ago, Chief Justice Vaughan said "Equity is a universal truth and there can be no precedent in it."

To return to the engineering aspects of the case, I by no means believe that the importance of the Ten Mile River development is confined solely to this emergency of the present year. The novelty, and the imminent danger of serious difficulties occurring in the Storm King deep tunnel crossing of the Hudson, makes it, in my judgment, impossible to predict with any reasonable certainty the time necessary to bring Catskill water to Croton Lake. I believe that many engineers feel exactly as you do as to this matter, and there is no question about the truth of your statement that the taking of Ten Mile River would have effected a saving of between fifty and one hundred million dollars, the larger amount being the one nearer the truth.

For my part, I thank you for your frank expressions concerning this subject, and hope that your warning will not fall upon deaf ears, although I fear it may.

C. C. Vermeule.

203 Broadway, New York, June 5, 1911.

Kennedy's Laws of Silting.

Sir: In your issue of May 18, 1911, p. 587, in the article by Mr. A. B. Segur, entitled "Notes on Three Irrigation Projects in the Punjab, India," we find reference to Kennedy's laws of silting. With our rather limited reference facilities we have been unable to check up the formula cited. We should very much appreciate reference to published data covering Kennedy's law, or, in lieu of the same, a statement as to the units or value used for the different factors in the equation and an explanation as to the relation between V_o and p, it being stated that V_o equals the critical velocity or the velocity of no silt, or no scour, and that p equals the silt carried at velocity V_o, which is the velocity of no silt.

Southern Power Co.,
C. A. Mees, Designing Engineer.

Charlotte, N. C., May 23, 1911.

[Kennedy's Laws of silting were advanced by Mr. R. G. Kennedy, at that time an Executive Engineer in the Public Works Department of India in a paper entitled "The Prevention of Silting in Irrigation Canals," published in the Minutes of Proceedings of the Institution of Civil Engineers, v. 119, 1894-95, p. 281 [Paper No. 2826]. The theories and conclusions there stated were the result of a series of observations made by the author at 30 different sites in India over 90 miles of irrigation canals, of various section, velocity and silt carrying capacity. He found that there is what he calls a "critical velocity" in any stream at which all silt already in suspension is carried without further deposition and at which also no further silt is scoured from the sides or bottom. This velocity, according to the observations, varies only with the depth of the stream according to the formula

$$V_o = cd^m$$

where V_o = critical velocity, sec.-ft.
d = depth of stream, ft.
c and m = coefficients varying with the regimen of the stream.

For the canals under observation this formula becomes

$$V_o = 0.84\ d^{0.64}$$

m is constant for all kinds of channel, but c varies as follows:

Light sandy silt	= 0.82
Coarser light sandy silt	= 0.90
Sandy loam	= 0.99
Coarse silt	= 1.07

Further he found that when
V = any velocity.
x = the amount of silt carried at V.
p = the amount of silt carried at V_o.

then $$x = p\left(\frac{V}{V_o}\right)^{5/2}$$

From this he deduced that knowing the amount of silt carried by the canal under its critical velocity, the amount of silt which would be deposited under any other velocity would be

$$p - x = p\left[1 - \left(\frac{V}{V_o}\right)^{5/2}\right]$$

If $(p - x)$ is found to be a minus quantity the formula gives the amount of scour.

It will be noted that this does not give any relation between velocity and silt carrying capacity, which is a matter of observation in each particular case. The formula is of value in determining the amount of silt which will be deposited or scoured or in designing the proper sized laterals or branch canals, taking off from canals of known velocity and silt-carrying capacity.—Ed.]

Kutter's Formula Values for Rock Channels; Umatilla River Gagings.

Sir: Relative to the inquiry of R. Mugnier in Engineering News of April 20, 1911, concerning the proper value of n in Kutter's formula in rock cuts:

While I was in charge of the work of the water resource branch of United States Geological Survey, Columbia River District, I made some measurements at the gaging station on Umatilla River near Umatilla, Oregon, to determine the changes in slope and the values of n for different stages of the stream. Four measurements were made during a flood, the results of which are given in Table I.

The bed of the river is in solid basalt rock. The velocities are always swift enough to prevent the deposit of silt or sand. The rocks are water-worn, but quite rough; there are no sharp corners or jagged edges. The roughness of the bed and banks would probably compare with an old cobble pavement somewhat the worse for wear and displacement of stones.

The slopes were determined by gages placed in stilling boxes 1,025 ft. apart. Measurements were made near the lower gage, from a cable which spans the river. Within the banks the character of the material on which the water flows is practically the same for all stages. During the time of making the measurements the river was falling slowly; the discharges in Table I., measured by current meter, are probably somewhat less than would obtain if the stage at each measurement had been stable. The values for the slope are the mean values read from a curve obtained by plotting the actual differences of gage height observed at frequent intervals from early morning of March 17 to late in the evening of March 18.

I have prepared Table II. from the discharge curve which has been developed at this station, using the slope obtained in the same manner at this and at other times. The values of n therefore more nearly represent stable discharges than those given in Table I.

The value of n is seen to vary from 0.0285 to 0.034 for a range of stage of 5 ft. This was somewhat of a surprise to me. The values vary inversely as the hydraulic radius.

These results indicate that Kutter's formula can only be used for approximate results. If we admit that the value of n is influenced by other conditions than the roughness of the bed over which the water flows, the formula of course becomes less useful. For rough jagged rocks, as would obtain in a newly excavated rock cut, a coefficient of n not less than 0.035 should, in my opinion, be used.

Very truly yours,
J. C. Stevens.

605 Spalding Bldg., Portland, Ore., May 24, 1911.

TABLE I.—GAGINGS OF UMATILLA RIVER NEAR UMATILLA, ORE.

Date, 1908.	Gage height, ft. Beg.	End.	Mean.	Area, sq. ft.	Mean velocity, ft./sec.	Discharge, cu. ft./sec.	Slope.	Hydraulic radius, ft.	C	n
March 17.....	8.15	7.92	8.03	1,070	9.82	10,500	.00354	5.48	70.5	.0282
March 17.....	7.75	7.57	7.66	1,000	9.23	9.230	.00362	5.07	68.1	.0290
March 17.....	7.37	7.20	7.28	919	8.62	7,920	.00370	4.80	64.6	.0304
March 18.....	6.20	6.10	6.15	710	7.35	5,220	.00392	3.81	60.2	.0312

TABLE II.—VALUES FROM RATING CURVE FOR UMATILLA RIVER.

Gage height, ft.	Area, sq. ft.	Mean velocity, ft./sec.	Discharge, cu. ft./sec.	Slope.	Hydraulic radius, ft.	C	n
4.0	325	4.24	1,380	.0043 5	1.87	47.0	.0340
5.0	505	5.86	2,960	.00415	2.77	54.7	.0323
6.0	688	7.14	4,910	.00395	3.70	59.0	.0316
7.0	875	8.35	7,300	.00375	4.58	63.8	.0305
8.0	1,065	9.58	10,200	.00355	5.46	68.8	.0294
9.0	1,255	10.43	13,100	.00335	6.32	71.7	.0285

Irrigation Administration in the Punjab.

Sir: As a contributor on the same subject, I read with great interest the paper of Mr. A. B. Segur on the Punjab Canal in Engineering News, May 18, 1911, p. 585.

The statement concerning the original proposal to tap the Sutlej River for the supply of the Lower Bari Doab Canal is quite new to me and is most interesting, as it shows that the surplus water in this great river is being reserved for a new canal system which some day is to irrigate parts of Rajputana. This latter country is, however, not a "State" but a congery of states. The impression to be gathered from Mr. Segur's remarks is that the Government of India impose on themselves a self-denying ordinance whereby they hand over the water of the Sutlej to a foreign state. This is not actually the case. Rajputana forms an integral part of India under the same Governor General, although the native states are granted autonomy and are not interfered with except in cases of gross oppression or misconduct, when the paramount power exercises its rights. The Government would construct and operate a canal of this description, as the native administration would be incapable of doing this effectively, and the cost would be refunded by the states benefited who would collect their own revenue, unless also this were done by the canal administration. There are several existing cases where canals run into and irrigate native states to their very great benefit.

W. G. Bligh.

44 Dupont St., Toronto, Ont., May 23, 1911.

A Short Cut in Estimating Weights of Material.

Sir: In estimating quantities of structural material it is convenient to take advantage of the simple relation that, with wrought iron at 480 lbs. per cu. ft., a bar 1 in. square and 1 yd. long weighs 10 lbs. The solution of the problem in your issue of April 27, p. 517, would then be

$$\frac{10}{3} \times \tfrac{1}{4} \times \tfrac{1}{8} \times 20 \times 45 = 750.$$

For a different metal, a correction factor may be included in the statement, as $\frac{15}{16}$ for cast iron at 450 lbs. per cu. ft., or $\frac{49}{48}$ for steel at 490 lbs. per cu. ft.

Sometimes the correction is preferably made by using a percentage factor in the footing.

For use with round sections it is only necessary to introduce the factor $\frac{11}{14}$, which is, very closely, $\frac{\pi}{4}$.

F. G. Frink.

Eugene, Ore., May 9, 1911.

Annual Convention of the National Electric Light Association.

The thirty-fourth convention of the National Electric Light Association was held in New York city, May 29, to June 3, marking the close of the twenty-fifth year of the association's existence. The total registration was 5,149, making this, it was claimed, the largest electrical gathering and the largest technical convention in the country. The center of activity was, of course, the engineering societies' building, on West 39th St. The facilities of the building were taxed nearly to the limit, but everything moved without inconvenience and with more dignity and dispatch than has often been noted elsewhere. There was no manufacturers' exhibit of electrical apparatus as in previous years on account of lack of adequate exhibition space close by. In place there was a catalog exhibit of many manufacturers in this line. The exhibition feature, however, has not been permanently abandoned and one will be seen at the next convention, to be held in Seattle.

The convention opened with a reception at the Hotel Astor on the evening of (Monday) May 29 and business began on the following morning. There were 18 sessions for over 70 addresses, papers and voluminous reports, to say nothing of four or five times that number of extemporaneous discussions on the many questions involved. This necessitated parallel sessions and evening attendance. For those whose interests were diverse, attendance at all the desired sessions was manifestly impossible. To help out as much as possible, the particular business of all sessions was posted on telephone-connected bulletin boards in each assembly, so that members were able to go from one session to another as they saw fit. The gaps left by such divided attendance were filled by the official "Convention Daily" supplied by the "Electrical World" at no small burden.

The scheme devised by the Building Superintendent for calling members desired at the telephone was much used and afforded great relief from frequent interruptions of the meetings for platform announcements. In each assembly room, a small electric projection lantern flashed on the front wall "Wanted at Telephone On Main Floor, Mr. A. B. Brown." This arrangement has now become permanent in this building.

The entertainment features of the convention were many. At the opening reception, the attendance was treated to an organ recital, a promenade concert and dancing. On May 30, the Brooklyn Edison Co., provided an excursion up the Hudson for the ladies and a trip to Coney Island for all the visitors. On May 31, there was to have been a ball game between teams from the Brooklyn Edison and Philadelphia Electric companies, for a cup given by the Westinghouse interests, but rain interfered. On June 1 there was a morning entertainment for ladies and three theatre parties in the evening for all. On June 2, the ladies were comforted by automobile rides and a concert tea at the Plaza Hotel, while the Sone of Jove (a society drawing its members from the electrical industry) had a dinner at Coney Island. On Saturday, June 3, the visitors were taken by the New York Edison Co. for a steamboat trip around Manhattan Island to visit the plants of the New York Edison, Interborough Rapid Transit and Astoria Light, Heat & Power companies.

General Sessions.

At the opening session of the convention there was the customary welcome to the city, given by Mr. John Purroy Mitchel, President of the Board of Aldermen, and the annual presidential address. In the latter Mr. W. W. Freeman, of Brooklyn, N. Y., reviewed the general growth and status of the association, following the example of his predecessors. In addition he made brief announcement of the recent conferences of the Association of Edison Illuminating companies, the National Electric Light Association, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, American Electric Railway Association, American Electrochemical Society, American Electrotherapeutic Society, National Museum of Safety, U. S. Bureau of Standards and the U. S. War and Navy Departments, looking to the formation of a national medical commission to report on most effective means of resuscitation from apparent death by electric shock.

Another familiar review which has long been a feature of the program of general sessions was the Report of The Committee on Progress, Mr. T. C. Martin, Chairman (and working majority). This was an interesting brief summary of progress in the industry and art of electric lighting, here and abroad. The trend of public opinion and judicial decisions on public-policy were also outlined.

Mr. Paul Lupke, of Trenton, N. J., contributed his annual uplift paper, this time bearing the title "Master and Men." It was a plea for the closer contact of the "big boss" with the rank and file of the workers when, and if, labor troubles were to be settled or betterment plans put into effect.

In the Report of The Insurance Expert, Mr. W. H. Blood, Jr., of Boston, some effects were briefly shown to have resulted from the campaign for lower rates on light and power-station fire-insurance risks. Figures which were presented last year showed that the rates of insurance companies in many localities were not logically based on the actual risk experienced. It was reported that the figures had not been effectively attacked and that most insurance companies were willing to revise rates, and in some cases had done so.

At the close of the opening general session, Mr. W. C. L. Eglin, of Philadelphia, presented the association, in the name of Mr. H. L. Dougherty, of New York, a painting of Miss Harriet Billings who as Assistant Secretary and Assistant Treasurer since 1891, had done most of the actual work of the association. Miss Billings is now in poor health and on leave of absence with salary.

Mr. T. A. Edison left his Orange laboratory for a part of a day and as "father of the industry" graced the convention with his presence. On the same day Mr. C. A. Coffin, President of The General Electric Co., of Schenectady, was elected an honorary member and delivered a congratulatory address. The H. L. Dougherty gold medal for the best paper presented before a local section was awarded to Mr. C. J. Russell of Philadelphia. A few minor constitutional amendments were passed; the Executive Committee was advised to establish an "information bureau" for the collection and exchange of technical data, etc. To this committee was referred the proposed code of standard line construction with power to adjust matters of conflicting policy brought up at the technical sessions.

The following officers were elected for the ensuing year: President, Mr. J. F. Gilchrist of Chicago; Vice-Presidents, Mr. F. M. Tait of Dayton, Ohio, and Mr. A. S. Huey of Oklahoma City, Okla. It was recommended that Mr. T. C. Martin, of New York, and Gen. G. H. Harries of Washington, D. C., be appointed Secretary and Treasurer, respectively.

"QUESTION BOX."—A brief and breezy report from the editor of the "Question Box Bulletin," Mr. M. S. Seelman, Jr., of Brooklyn, N. Y., recounted the hardship of detailing to any one member company the privilege of running the Box for a year and presented the recommendation that the association hire an assistant secretary, whose work should be especially to attend to this correspondence and to edit the monthly Bulletin. The Question Box Revision Committee concurred in this recommendation.

HAND BOOK AND LIBRARY.—Reports of the Committee on Electrical Solicitors' Handbook and of the Library Committee, being very brief, were presented together by Mr. Arthur Williams, of New York. The former report described changes in the association's "pocket assistant." The latter chiefly recommended that this association (and other similar ones) contribute some small sum, like $250 per annum to the library of the Engineering Societies Building in New York, for the accumulation of works on public utilities. It was stated that the library was unable to accumulate much desired material on such topics, since it was held to be not strictly engineering literature, which absorbed all the library funds.

COMPANY-SECTION ORGANIZATIONS.—A paper, "Company and Section Bulletins," was read by Mr. E. A. Edkins, of Chicago. Here was given a review of the development of the "house organ," which the author believed increased loyalty and efficiency of employes where it was "internal" circulation and cultivated friendly relations with the public when widely circulated.

This paper was followed by long discussions of the work of the several company sections all over the country. The opinions seemed unanimous that the educational and entertainment possibilities were great and helped to make the new employment attractive.

WELFARE OF EMPLOYES.—To make the report of the Public Policy Committee more impressive, the meeting for its presentation was held in the New Theatre and the Hon. Charles Nagel, Secretary of Commerce and Labor, delivered an address. This committee's function is to express the association views on various public questions and it is made up of the most prominent men of the industry. The present personnel is as follows: Messrs. C. L. Edgar of Boston, N. F. Brady of New York, E. W. Burdett of Boston, H. M. Billesby of Chicago, H. L. Dougherty of New York, W. W. Freeman of Brooklyn, G. H. Harries of Washington, Samuel Insull of Chicago, J. B. McCall of Philadelphia, Samuel Scovill of Cleveland, C. A. Stone of Boston and Arthur Williams of New York. The committee made specific recommendations as to the way of putting in force (1) accident insurance, (2) sickness and death benefits, (3) service annuities, (4) profit sharing, (5) employes' savings and investment funds, (6) life insurance. Members were urged in the first case to assume full responsibility for restoring an injured employe to health as rapidly as possible, for continuing his wages, for compensating for decreased capacity and death. The first three items were to be assessed on the industry as a part of labor costs.

Secretary Nagel declared in his address that the announced provisions must appeal to every observing citizen and said that they must not be merely altruistic but to be successful must be correct from a business standpoint. He believed that such voluntary steps toward assumption of proper liabilities would head off much unripe legislation and prevent drifting into unsafe business conduct against which the strong arm of the law had to be invoked.

RATE QUESTIONS.—The last general session was devoted to discussions of rate making and allied questions. All the discussions were notably broad minded and showed an appreciation of the rights of both consumer and investor. Mr. H. M. Billesby of Chicago opened the session with a paper "Breadth of Vision in Public Utility Appraisals." He stated that rates were coming more and more to be based on property appraised plus some values of a working concern, the tendency being to show greater respect for "going values." He claimed that it would be necessary to allow the investors some "no-par," "profit" or "water" stock unless a greater return on other investments were allowed. The main contention of the paper, however, was that engineers in making either estimates or appraisals were so prone to underestimate that some percentage should always be allowed to compensate for the generally experienced over-run of cost over estimate. He believed that if data of over-run in public-utility plants were compiled it would make a surprising show. He made a hope for greater profit rather than mere acceptance or anticipation of public demand the basis for system extensions.

In discussing this paper, Mr. Samuel Insull of Chicago very earnestly urged on everyone the utility and necessity of an appraisal of their plant, that they might know the exact value of the property. He advised the employment of an

independent engineering firm and warned that a cheap investigation was not to be expected.

A paper "Elements Affecting the Fair Valuation of Plant and Property" was presented by Mr. W. F. Wells, of Brooklyn, N. Y. This was a short collection of definitions of some prominent factors to be considered in original and reproduction costs of a public-utility concern—what constituted "fair value," what "costs" should include, and what the author considered as "true depreciation." He did not approve of defining depreciation as "equal to the ratio of age to estimated life, times service value if properly maintained," "service value" being original cost less estimated scrap value. He maintained that "depreciation should not be considered as impairment of capital, but rather unaccrued expenses," replacement or withdrawal being charged to operating expenses when the property ceases to earn.

In the discussion Mr. Henry Floy of New York spoke of the need of everyone's attaching equivalent meanings to certain terms and called attention to the use of "service value" and "depreciation" in the paper. He advocated charging off an "actual depreciation" in contrast to the "theoretical depreciation" or straight-line decrease in value. For determining actual life of property, sufficient data were lacking and he hoped to see manufacturers, public-utility and consulting engineers combine efforts to secure such. Mr. J. F. Klump, of Philadelphia, advised all interested to study the work of Alvord and Metcalf on the evaluation of water-works property.

The Committee on Rate Research reported through the chairman, Mr. J. F. Gilchrist of Chicago. They found little uniformity in rate making methods and schedules but nevertheless great similarity in resulting net costs except in the case of small-service classes. The broad establishment of some uniform fair and rational basis of rates for such classes was recommended as "the opening wedge for uniform national rates for electric light and power." The committee included in its report a scheme for comparing resultant rates in various cities, by solid geometry, the three dimensions representing (1) kilowatt demand, (2) kilowatt-hour consumption, and (3) actual bill. A set of solid models was exhibited by the originator of the scheme, Mr. H. E. Eisenmenger, of Cleveland.

In the paper "Some Reasons for Difference in Price for Different Services," Mr. N. T. Wilcox of Lowell, Mass., reported on some investigation of plants in several towns of 5,000 to 100,000 inhabitants. He found a great difference in the total investment required per kilowatt of station capacity varying from $375 for small residences to $175 for 1,000-KW. blocks of three-phase power. The annual consumption varied from some 800-KW.-hrs. per kilowatt of capacity in the first place to 3,000 and more in the last case. These and other figures were advanced to substantiate the claim that

* * * within reasonable bounds reduction in cost is indicated largely by the size of the installation; for average normal conditions and various classes of service there are certain natural discounts depending largely upon the cost of the complete equipment required and modified by the hours of use.

Mr. Douglas Burnett, Consolidated Gas-Electric Light and Power Co., Baltimore, presented the paper "Standardizing Electrical Sales." It contained first a brief statement of the necessity of reducing to printed form all of a company's rates and regulations, of standardizing the lines of equipment to be supplied and fixing a complete price list. The larger part of the paper described how these things had been accomplished by the author's company and how the new business was handled.

An echo of the much heralded "efficiency engineering" penetrated the convention, in a paper "The Possibilities of Economy in The Operation of Light and Power Companies Offered by Scientific Time Study," by Mr. L. B. Webster, of Marion, Ind. This pointed out a few chances for improvement over present conditions. For instance, a case was cited where 18 firemen were found, on an average, to be actually working only 40% of their time, and a considerable part of this work was spent in opening and closing doors, handling tools, etc. It was found, moreover, that firemen throw coal at fairly regular intervals irrespective of load, the amount of fuel fired being varied by varying the amount per shovelful. In the same plant, the engine-room force came under scrutiny and it was shown that the engineers, switchboardmen and arc-machine tenders were spending from 8 to 35% of their time on their own true duties, 26 to 35% on the duties of cheaper men in order to keep themselves apparently busy, and during 39 to 57% of their time were idle. The remedy proposed in this case was in reducing the force and rearranging the duties, having the regular engine-room force act as helpers whenever possible to the regular repairmen, cutting down the number of outside helpers needed. A study of the work of erecting and repairing transmission lines was attempted. In the first variations of 50 to 100% were seen in the time required to do similar simple pieces of work. In tightning and tying new wire, already strung, the linemen's time was accounted for as 20% on work for which he was especially fitted and paid, 40% on cheaper men's work and 40% doing nothing. Mr. Webster felt that it would be necessary, in increasing the efficiency of such workers and to eliminate discontent, to share the economic gain by raising the rates of pay.

Mr. H. F. Porter, in discussion, cautioned about the great number of variable factors, in studying labor in connection with machine efficiency, which had to be held constant before dependable information could be secured about the labor. He also mentioned the danger of over fatigue, in increasing the efficiency of labor—whether the extra exertion was willing or forced. There had been found generally a great field for effort in removing obstructions to better work and instructing men in improved work, in which cases it was possible to increase the efficiency and lighten the burden of labor simultaneously.

Technical Sessions.

There were in all six sessions devoted to engineering-work discussions, although they were further separated into "technical" and "power-transmission" meetings.

METERS.—The Meter Committee presented, as usual, a formidable document but a useful one. This report comprised, first, information of a general nature on the new apparatus of several companies, on testing equipment, eliminating the expense of repeated visits to get a meter reading, costs of the meter department and how the items should be separated. Secondly, in the report were found a new section of a previously proposed "meter code" outlining good practice for a meter department, this section dealing with maintenance, inspection and repairs. The discussion of the report turned on points in the "code" where members had found trouble—such as proper oil, use of sapphire rings with diamond-cup bearings, frequent regrinding of jewels, etc.

GROUNDING LOW-TENSION CIRCUITS. — The committee on this subject, continued from last year for educational work, reported that they found differences of opinion existing only as to the voltage to which grounding of secondary circuits should be carried. Their position and the situation were thus explained.

With very few exceptions, every one who has given this matter serious consideration agrees that secondary alternating current circuits should be grounded. The only difference of opinion which now exists is as to what voltage grounding should be carried. The members of this Committee have been unanimous in their opinion that it is unwise to carry this grounding above 150 volts. On the other hand, such good authority as a corresponding committee of the American Institute of Electrical Engineers wishes to carry the limit to 250 volts.

The whole question resolves itself, we believe, into a decision as to which is the greater menace—a constantly grounded 250-volt circuit, and so making it possible to receive, at any time, a shock of 250 volts, or leaving the 250-volt circuit ungrounded and the customer subject to a 1,000-volt or higher voltage shock which would be brought about by the breakdown of a transformer or by primary and secondary lines crossing.

It was reported that the insurance underwriters had decided to recommend the universal grounding of secondary circuits of up to 150 volts potential. In the discussion Mr. Farley Osgood, Newark, N. J., explained that the underwriters were unable to make such a rule mandatory since the grounding did not appreciably decrease the fire hazard. Mr. L. F. Mowry, of Providence, R. I., cited several accidents from grounded 250-volt circuits which showed that the immediate effects of 250-volts contact with the body were as bad as 2,500 and that the victim was unable to get clear of the contact alone and might be badly burned or killed. Much trouble was reported in securing a good grounded connection where pipe systems were not available. Some had success with ground cones in charcoal; others had none. Some liked pipes in salted earth and others did not.

Mr. P. M. Spencer, of Pittsburg, presented a paper, "Grounding Low-Tension Circuits as a Protective Measure," in which he explained how on the low-voltage windings of a transformer there might exist, by condenser action, a stated charge having a potential of as high as 115% of the high-tension terminal voltage. It was shown how the primary-secondary and secondary-case combinations formed two condensers in series between main-line and ground, the potential being distributed in inverse proportion to the static capacity of the two combinations. It was admitted, however, that the current which could flow would be inappreciable except for the high frequencies which accompany lightning discharges and arcing grounds on the line.

NEW SINGLE-PHASE MOTORS.—Mr. W. A. Layman, of St. Louis, in a paper "Recent Improvements in Single-Phase Motors" described a fixed-speed and a variable-speed motor having desirable characteristics for single-phase circuits. The first of these was essentially a "squirrel-cage" induction motor with a superimposed commutated winding on the rotor and a compensating field coil. The commutated winding increases starting torque and the compensating field improves the power factor by causing a "leading" current to the motor (maximum value of current ahead in time of voltage maximum). The torque drops 1.5 after starting, remains constant until nearly full speed, then sharply rises, and finally sharply falls to full load value which is 3.5 the starting torque.

The second type of motor had the general performance characteristics of a shunt-wound, direct-current type. A specimen motor exhibited ran between 750 and 2,250 r. p. m. (2 to 5-HP.) in six steps. The main field was connected directly across the line, the rotor circuit (commutated) having two sets of brushes supplying auxiliary fields. The speeds depending on the number of turns put into connection with the rotor brushes. Tests showed very little slip between no load and full load for each speed stage and a high power factor of 80 to 100% and with leading current at light loads with medium speeds.

The discussion hinged on the desirability of having such a motor, with high power-factors, available for central station companies.

MODERN STATION LOADS.—In the paper "The Relation of the Modern Load to The Station Equipment" Mr. F. D. Newbury, of East Pittsburg, discussed the factors which had to be investigated in selecting equipment for an alternating-current generating station. These remarks dealt principally with the power factor of different lighting and power-service loads, with the possibilities of combining loads to increase power factor and decrease investment for a given capacity.

In the discussion, troubles were related of having welding processes as small-station loads on account of sudden heavy currents. Mr. P. M. Lincoln suggested that it might be well to interpose a motor-generator set with a heavy flywheel to minimize fluctuations and average the loads.

OVERHEAD LINE CONSTRUCTION. — The chairman of the Committee on Line Construction, Mr. Farley Osgood, of Newark, N. J., reviewed the principal features of a report of 195 pages in

which definite standards were proposed for (1) overhead lines for 2,300-volt distribution and street lighting circuits and materials, (2) secondary circuits between transformers and buildings, (3) joint use of poles by lighting and telephone companies, (4) overhead crossings of electric light and power lines. Mr. Osgood announced that the report was presented for adoption as a working code, which had been very carefully prepared by a great many men and after years of trouble. Piecemeal criticism was not invited. There was some opposition to what seemed "road-roller" methods but the chairman skillfully replied to all attacks on the code and it finally was recommended to the executive committee for adoption with such changes as good policy might require, to avoid misconception of purpose.

TIMBER PRESERVATION.—The bulky report of the Committee on Preservative Treatment of Poles was reviewed by the chairman, Mr. W. K. Vanderpoel of Newark, N. J. Creosoting was the recommended preservation, and the pressure process of injecting the oil was preferred, although the "open-tank" scheme was favorably described for some conditions; brushing was held to be quite too uncertain. The report included specifications for the preservative and the processes, by which it was believed that any company might be quite successful in treating pine poles. For cedar and chestnut the committee felt there was less need of treatment and less success in securing good penetration, though there was some benefit in preventing decay at the ground line. Dr. Hermann von Schrenk contributed an appendix on the treatment of poles in Europe, and Mr. H. F. Weiss one on the open-tank process. Another appendix was an abstract of a government bulletin on pole borers and still another showed statistics, on treated and plain poles, arms, brackets and pins purchased in the country up to 1909, as collected by the U. S. Forest Service.

UNDERGROUND LINE CONSTRUCTION. — This committee, Mr. W. L. Abbott, of Chicago, chairman, reported the result of its studies into conduit construction, cables, cable troubles and auxiliary equipment. The report included also (1) recommended specifications for cable joints, (2) comparisons of conduit materials, (3) prevention of electrolysis of lead sheaths, (4) locating and repairing faults.

PLANT REPORTS.—In the paper "Load Reports of an Electric System," Mr. A. S. Loizeaux, of Baltimore, described the tabular and graphic daily, monthly, and annual reports which were prepared from station records, to show concisely and conveniently certain information often needed by the officers. These included, for instance, daily, monthly and yearly output summaries, special day-load curves, maximum peaks and maximum outputs, load factors, etc., etc.

ELECTRIC LAMPS.—Mr. W. F. Wells, of Brooklyn, as chairman of the Lamp Committee, described general progress in the development of metallized-carbon and metallic-filament incandescent lamps. The discussion hinged on what policy of renewals should be pursued by a lighting company with the more expensive high-efficiency types.

PRIME MOVERS.—A report of the Prime Movers Committee concerned itself with standard apparatus in use. Minor new developments of the manufacturing companies were described and several quite minor difficulties were briefly discussed —such topics as condenser-tube troubles, control of circulating water, clean air for turbine cooling, erosion of turbine casings, etc. A new "bleeder" type of steam turbine was described by which exhaust heating lines could be supplied with steam at low pressure as needed without passing through reducing valves. Two appendices, by Messrs. J. B. Klumpp of Philadelphia and W. N. Ryerson, of Duluth, reviewed the extent to which electric companies were employing gas and hydraulic prime movers.

ELECTRICAL APPARATUS.—Mr. L. L. Elden of Boston, as chairman of the Committee on Electrical Apparatus, described some of the results of some short-circuited experiments with a 12,000-KW. generator at Chicago and outlined some construction recommended as a result. For instance, it was found desirable to permanently install heavy inductance coils in the generator leads to cut down the short-circuit current, protecting the generator and also the switches which had to open in case of short circuits. In the report there was also a great amount of material on the design of switchboard parts to prevent mechanical rupture from magnetic stresses, on relays for tripping heavier apparatus, on voltage regulation, rectifiers, electrical testing, etc.

"Ventilation of Turbo-Generators" was the title of a paper by Mr. R. B. Williamson, of Milwaukee, in which computations were shown of the amount of air needed in generators for proper cooling. The provisions necessary to secure introduction of the air properly cleaned were described also.

Mr. H. O. Troy, of Schenectady, read a paper "Recent Development in Self-Cooled Transformers," which contained much of an historical nature on the development of transformer construction. The various expedients employed to increase the dissipation of heat from self cooled transformers were described. In the discussion on this point, Dr. A. S. McAllister of New York, called attention to the recognized fact that the effective cooling of pipes and corrugations of a transformer tank was due to convection and not radiation unless the overall diameter was increased.

GOVERNMENT CONTROL OF WATER POWERS.—The conference called by the association in April for the discussion of a government policy in regard to the control of power sites was reviewed by Dr. A. S. McAllister of New York. The principal feature of the conference was the address of the Hon. W. L. Fisher, Secretary of the Interior, in which he stated that the government had no fixed policy and was postponing the formation of a well-defined policy until it had secured requisite information. It was announced at this convention that steps had been taken to secure the cooperation of various engineering and commercial bodies as seemed expedient in conferring with state and national legislative and executive branches in the development of a constructive policy for prompt development of water powers.

ELECTRICITY FOR RAILROADING. — Mr. Fred. Darlington of East Pittsburg in the paper "Central Power Plants and Electricity Supply for Trunk-Line Railroads," argued that the railroads were going to demand enormous amounts of energy and that these should be supplied by the great central-station and transmission-system concerns which he foresaw. The discussion turned largely on the great general advantages to all that were possible in building up a diversified station load to increase the ratio of average load to maximum-peak.

LIGHTNING PROTECTION. — The Committee on Protection From Lightning, Mr. B. E. Morrow, of Albany, chairman, presented a brief report in which it was stated essentially that lightning protection had advanced to such a point that it was now largely an economic question of balancing the cost of protection against the value of apparatus protected at various parts of a system. Several guiding recommendations were appended, however, such as (1) the use of a grounded overhead wire along the transmission lines, (2) insertion of choke coils in all circuits leaving a generating station, (3) the use of electrolytic arresters.

In the discussion, Dr. C. P. Steinmetz of Schenectady, dwelt on the present economic aspects of protection as an indication of the high degree of success attained. He also stated that there had been an equal advance in the theory of high-potential, high-frequency disturbances and that the laws connecting these were as simple as Ohm's law.

OIL FUEL.—Mr. H. A. Wagner, of Baltimore, in his paper "Increasing the Flexibility and Reducing the Cost of Operation of Steam-Boiler Plants by Use of Oil Fuel," described a back-end installation of auxiliary oil burners. Boilers were kept "banked" by running one burner (out of four) all the time. For emergency service the boilers could be made to steam in a quarter the time with coal fuel. In spite of the increased cost of oil over coal the banking by oil was the less expensive on account of having conditions for economical combustion. Operation had shown this double-ending increased the boiler capa by 67% and saved 40% in the rated boiler c ity needed to carry a given peak load. M G. Kennedy, of Syracuse, described a some similar and successful equipment.

COST OF STEAM POWER. — Messrs. Walbridge and E. M. Gilbert, of New York paper "A Method of Determining the Co Steam Power Under Various Conditions" a graphical method of finding for addition cost of steam per kilowatt-hour for various movers under various load conditions, cost banking boilers, cost of labor, etc.

OPERATION OF TRANSMISSION SYST —A topical discussion was scheduled on this eral subject to close the meetings of greate gineering interest. The discussion was open Mr. D. B. Rushmore, of Schenectady, who communication from Mr. Max Hebgen, of Montana, who designed the highly successful 000-volt line from Great Falls to Butte. Mr gen outlined what he considered essential liable service, which may be briefly summ as (1) greater factor of safety in insulatio careful determination of loads and stresses lines and towers, (3) special structures for cr country and standard type with large margin rough country where loads were problema (4) use of only medium hard-drawn copper wires, (5) well hinged insulator clamps, (6) for lines to important centers, duplicate or triplicate lines along different routes but sectionalized and cross connected at middle, (7) eternal vigilance.

Communications from others emphasized one or more of the same points. The oral discussion was largely an interchange of experience in various operating details. It was closed by Mr. Rushmore who reviewed present demands. He had found among manufacturers a necessity for practically uninterrupted power supply and the feasibility of a system depended on the cost of giving this. There were two ways of operation, (1) by relying on automatic apparatus, and (2) by depending on skillful operators. With recent progress there was more attention to increasing fixed charges which led to reducing operating charges with a better service resulting at the same total cost.

ACCOUNTING PAPERS.—The following papers were presented at sessions for those interested in the accounting end of the business.

(1) Committee Report on Uniform Accounts; Mr. J. L. Bailey, of Baltimore, Chairman.
(2) "Handling Customers' Orders"; Mr. R. F. Bonsall, of Baltimore.
(3) "Collection of Bills"; Mr. E. J. Bowers, of Kansas City.
(4) "Electric Vehicle Accounts as Applied to a Central Station Department"; Mr. Hermann Spoehrer, of St. Louis.
(5) "Tracing Store-Room Material"; Mr. J. T. Brady, of Denver.
(6) "The Purchasing Department"; Mr. T. W. Buxton, of Brooklyn.
(7) "Advantages of a Job Cost System"; Mr. Alec Holme, of New York.
(8) "General Office Accounting"; Mr. Franklin Heydecke, of Newark, N. J.
(9) "Accounting for Depreciation"; Mr. H. M. Edwards, of New York.
(10) "The Extent to Which a Tabulating Machine Can Be Used in Accounting"; Mr. Wm. Schmidt, Jr., of Baltimore.

COMMERCIAL PAPERS.—There were parallel sessions for the new commercial section, embracing sales and advertising men. The following papers in these lines were scheduled.

(1) Report of Committee on Power; Mr. E. W. Loyd, of Chicago, Chairman.
(2) Report of Committee on Electricity in Rural Districts; Mr. J. G. Learned, of Chicago, Chairman.
(3) Report of Committee on Ornamental Street Lighting; Mr. W. R. Collier, of Atlanta, Chairman.
(4) Report of Committee on Electric Vehicles; Mr. J. T. Hutchings, of Rochester, N. Y., Chairman.
(5) Report of Committee on Residence Business; Mr. C. N. Stannard, of Denver, Chairman.
(6) Report of Committee on Electric Heating and Refrigeration; Mr. F. H. Gale, of Schenectady, Chairman.
(7) Report of Committee on Improved Wiring and Equipment Standards; Mr. M. C. Rypinski, of New York, Chairman.
(8) Report of Committee on Industrial Lighting; Mr. M. S. Sloan, of Birmingham, Ala., Chairman.
(9) Report of Committee on Electric Signs; Mr. E. L. Callahan, of Chicago, Chairman.
(10) Report of Committee on Competitive Illuminants; Mr. H. J. Gille, of Minneapolis, Chairman.
(11) Report of Committee on Advertising; Mr. C. W. Lee, of New York, Chairman.
(12) Report of Committee on Functions of a Sales Department; Mr. T. I. Jones, of Brooklyn, Chairman.

The Ten Mile River and the New York City Water Supply.

In our issue of May 18 we argued that New York City proceed at once to take water from Ten Mile River, just north of the Croton drainage area, to avert the danger of a water famine which will continue to hang over the city until the Catskill aqueduct is finished.

The only engineering argument of any importance advanced against this proposal is that if drought continues to affect the Croton watershed so that more water is needed the Ten Mile River will also be affected and might have only a trifling flow by the time a pipe line were built to reach it.

In view of arguments of this sort it seemed a matter of interest to determine something of what conditions are on the Ten Mile River at the present time after a period when the Croton watershed has been parched by an almost continuous drought lasting through the month of May.

A member of the editorial staff of this journal made last week an examination of the Ten Mile River at the site of which we proposed for a pumping station. The examination was made, it should be said, and the accompanying photographs of the river were taken, before the rainfall of Wednesday, May 31.

Fig. 1. The Ten Mile River at Webatuck Bridge Looking Upstream.

Fig. 2. The Ten Mile River Near South Dover Looking Down-Stream.

It was observed that through the Croton drainage area all the streams leading into the storage reservoirs are mere trickles running between high, wide banks or else the stream channels are absolutely dry. The Croton reservoirs themselves were seen to be far below their normal levels. North of the Croton drainage area there are still evidences of drought, but in several of the creeks and rivers observed there a good-sized flow of water was found.

The two views on this page show the Ten Mile River near Webatuck, N. Y., from photographs taken May 27. The stream at this point has an approximate width of about 70 ft., and an average depth of some two feet. Rough estimates indicated a stream flow in the neighborhood of 80,000,000 gallons per 24 hours. The water was beautifully clear. Two days after these views were taken, a heavy rain fell over a large part of the Ten Mile and Housatonic drainage areas, although there was only a trace of rain on the Croton water shed.

These two views were taken near the location of the pumping station proposed by Engineering News, just where the river bends to turn east toward the Connecticut line. The dam proposed by Mr. John R. Freeman, in his original report advocating the use of this stream, was to have been located about midway between the two locations shown, which are about a mile apart.

THE NEW UNION PASSENGER STATION at Worcester, Mass., was opened to traffic on June 4. The station is used jointly by the Boston & Albany R. R., the Boston & Maine R. R. and the New York, New Haven & Hartford R. R. The station is elevated and its use abolishes several dangerous grade crossings. The main structure is built of white granite, white terra cotta, marble and buff brick. Its construction was entered into jointly by the three railways and the City of Worcester at a cost of over a million dollars.

The Iron-Ore Deposits of the Moa District, Oriente Province, Island of Cuba.*

By JENNINGS S. COX, JR.,† M. Am. Inst. M. E.

The following notes, prepared in 1908, as the result of a personal examination and extensive explorations under my direction in 1906, have been revised and greatly augmented after two subsequent visits and further explorations in 1910.

The hard iron-ores of the south coast of Oriente Province, in the island of Cuba, have been known for many years, in fact one mine has been in operation for more than 20 years; but it is only within the past four years that the large mantle-deposits of brown ores of the north coast have attracted serious attention. It is the purpose of the present paper to give some account of the exploration of the Moa deposit and to call attention to its commercial importance.

The Moa district is situated on the north coast of the Province of Oriente, which is the most easterly province of the island of Cuba. It lies on the northern or seaward slope of the mountain range which, under various names, follows the north coast-line of the island, as a series of disconnected hills in the four central provinces and as a bold and continuous range, that forms a distinguishing feature of the landscape, in the most westerly province of Pinar del Rio and the most easterly province of Oriente. Moa lies about 35 miles west of the town and harbor of Baracoa, and nearly 45 miles east of the spacious harbor of Nipe. The district is unsettled except for a few fishermen's huts near the coast.

Discovery.

Both in the Mayari and Moa districts the so-called "King's Highway," as the rough pony-trail is somewhat pompously termed, runs directly over the ore. In the Mayari field the Spanish troops during the ten years' war built a small fort, complete with its moat and bastions, entirely of the iron-ore. This was intended to guard the telegraph-lines, which followed the trail, as well as the trail itself. It is evident, therefore, that in both districts, as well as in Taco and Navas, the red earth was well known, but had never been recognized as ore. The discovery that it was ore was a gradual process.

More than 20 years ago a number of claims were located, or in the Spanish term "denounced," in the Moa district. They were near the coast and were confined chiefly to the occurrence of boulders and hard ore, and as the quantity of these was not great, and as some of the earlier samples were extraordinarily high in chromium, the district did not attract any attention and some of the claims were abandoned. Again, about eight years ago, interest was renewed in the deposit and a number of claims were denounced. To my knowledge, at least three different engineers reported on the deposit at different times and their conclusions were unfavorable.

This result seems to have been due to the fact that everybody considered only the shot ore and boulders. The possibility of concentrating the former by washing it from its earthy matrix was discussed more than once. It had not yet dawned on any one that the earthy matrix itself, that great mantle covering so vast an area for a depth of 18 ft. and more, was really just as good quality ore as the concretionary forms on which attention had been concentrated. The report of a Spanish engineer that there were 35,000,000 tons of ore on the claim which he examined at Moa, was received with amused tolerance. He was, in fact, not far from the truth, though he himself did not claim that the earthy mass was ore, and incorrectly relied on the shot ore and boulders to yield his tonnage.

It was in the Mayari district, where systematic explorations were undertaken as early as 1904, that the truth came to light. Even here the earliest explorations were conducted under my direction on the hard-ore beds or layers already noted. A casual sample in a sink-hole directed attention to the quality of the red earth as being in no way different from that of the planchas, as the natives term the beds of "hard" ore. Even after the quality of the red earth was known, the yellow ore lying below it looked so like a simple clay that it was neglected, until systematic sampling and analysis developed the fact that it was as high, and probably higher, in iron-content than the hard ore and the red earth.

Thus it slowly became apparent that, from the surface to the underlying serpentine, the whole mass was in effect homogeneous, the occurrence of concretionary forms being due to local conditions that did not alter in any marked degree its chemical composition, and the variations in color being due to its more or less hydrated condition. Then, for the first time, the enormous extent and vast commercial importance of these ore-bodies were grasped.

Following this discovery in the Mayari district, a great number of claims were denounced in Moa, but no explorations were undertaken until the Spanish-American Iron Co., which owned and had explored the Mayari district, began the exploration of its claims at Moa.

Exploration.

This work began in December, 1905, and was completed in July, 1906. During a part of that time two full parties were in the field, more than 50,000 acres of ore-land were examined, the district was mapped, hydrographic surveys were made of Moa bay, and several thousand samples of ore were taken and analyzed.

The nature of the ore-body lends itself to exploration by a method which was developed at Mayari, and which merits description here. The ore can be bored by an ordinary carpenter's auger, and its consistency is such that the entire shaving remains in the auger, which is withdrawn and cleaned every four complete turns, and thus an accurate sample of the ground bored is secured. In spite, or better, because, of the high percentage of water in the ore the hole does not cave, and by cleaning it frequently, to avoid getting scrapings from the upper portions in the lower samples, the correctness of these can be assured. By using sectional rods, with a screw-thread at each end and connected by a sleeve-nut, holes have been bored more than 80 ft. deep.

The men acquire great facility in handling the augers and can bore very rapidly, covering a wide area each day. In no other way would it have been possible to explore this large territory except with much difficulty and at great expense. Occasional pits are valuable as a check on the borings and to permit a study of the ore at various depths, but no system of pits or tunnels could have done the work so thoroughly in the comparatively short time that the borings accomplished these results.

The boring system is dwelt on here as it not only affords an inexpensive manner of determining in advance the exact quality of the output for any given length of time, but also, from the knowledge thus derived of the topography of the underlying rock, it enables the mining-work to be planned for years in advance.

In this manner more than 900 borings were made, and samples were taken of every 6 ft. of each boring, and sometimes oftener. In a number of cases these borings were stopped by hard ore. A means of penetrating this has since been devised, and, in practically all cases, the usual ore was found below the shell of hard ore, frequently better in quality than that found above.

The borings were spaced generally at intervals of 1,000 ft., although in some cases rows of borings were separated from one another by a greater distance. The claims thus systematically explored were those referred to as the "Moa group," and which cover a total area of 13,832 hectares, or 34,179 acres. A few borings were made on most of the other claims then existing in the district; this work covering another 8,572 hectares, or 21,181 acres. In 1910 systematic borings spaced 250 m. apart were made over the claims covering 5,460 hectares, or 13,492 acres, known as the "Rodrigo group," and which form a compact group just south of the great Punta Gorda claim.

The ore-area explored on the Moa group was 8,100 hectares out of a total of 13,832. Nearly 1,000 hectares of additional ore-ground were not explored in 1906, as they were in the southerly portion of the Punta Gorda claim, and were separated from the original explorations by barren ground. They were subsequently explored in connection with the group of claims just south of the Punta Gorda.

Over the area of 8,100 hectares or, more exactly, 874,000,000 sq. ft., the average depth of the ore was found to be 18.1 ft. As the ore varies in density, a number of tests were made to determine the number of cubic feet to the ton. This varied from 15 to 24, with an average of 18.5; but, for the purpose of calculating tonnage, 20 cu. ft. of the ore in place has been taken as representing a ton.

The 874,000,000 sq. ft. of ore 18.1 ft. deep, at 20 cu. ft. to the ton, would give 791,000,000 tons, but as a matter of fact the borings near the edge of the ore-body are shallower and represent smaller areas, and, in calculating the ore-tonnage, the depth of each boring was multiplied by the area it represented and the pro-

*Abstract of a paper published in the March, 1911, "Bulletin" No. 51, of the American Institute of Mining Engineers.

†Santiago De Cuba, Cuba.

duct divided by 20, which yielded a total tonnage of 803,000,000 tons in the Moa group.

It might be argued that the great tonnage above shown is based on too small a number of borings; and such a point of view would not be unnatural to an engineer accustomed to work on veins or limited areas; but a simple inspection of the ground by an engineer, having before him that proof of the homogeneity of the ore-body which chemical analysis affords, will convince him of the accuracy of the method.

As a final proof, the entire exploration-work, by which the 803,000,000 tons were developed, was checked in 1910 by an independent engineer, who rebored about one-half of the original work, and also made intermediate borings, which confirmed the results from surrounding borings. He also explored, for the first time, nearly 1,000 hectares on the Punta Gorda claim, and about 540 hectares on smaller claims not previously explored, checking very closely the original results and increasing the total tonnage to 865,000,000 tons.

In the Rodrigo group, which lies to the south of the Punta Gorda claim, complete explorations have developed 224,000,000 tons of ore.

The estimated ore in the mining-claims which were less thoroughly explored, but where the results may be regarded as fairly accurate, gives a total of 280,000,000 tons. We have thus in the Moa district proper as the result of my explorations 1,307,000,000 tons of ore, which total has been increased by the work of others. These are startling figures, but their accuracy is unhesitatingly affirmed.

Such a body of ore lying on the surface, with no further over-burden than the pine timber and hardwood forests, extending from the shore of a deep-water bay over a country perfectly accessible for a railroad, apart from its interest to the scientist, compels the attention of the engineer for its commercial possibilities.

Quality of the Ore.

The iron is present in the lower levels practically all in the form of limonite and possibly other hydrated oxides. Near the surface it has parted with some of its combined water and oxygen, and hematite and magnetite predominate over the limonite. Alumina and chromium are fairly constant, but nickel and cobalt increase materially in the lower levels.

An uncompensated average of samples over the entire area, including all grades of material, gives the following results:

	Per cent.
811 samples, Fe	41.32
568 samples, SiO_2	7.22
568 samples, Al_2O_3	14.81
568 samples, Cr	1.58
202 samples, P	0.012

The nickel and cobalt vary from 0.44 to 1.28, with an average of 0.8 per cent.

Taking all the ore containing more than 30% of iron, we have:

	Tons.	Per cent.
Moa group	768,790,000	42.9
Rodrigo group	215,071,200	41.4
Compensated	983,861,200	42.57

Add to this content of soluble iron 1.5 for iron and nickel and we have 44.07%. The combined water exceeds 14%, but 12% has been assumed as more conservative. Expelling this water, we have 44.07 divided by 0.88, or 50% of metallic units in this 983,000,000 tons of ore.

The 280,000,000 tons, estimated in other claims less accusately explored, are a part of the same great ore-body, continuous and homogeneous with the remainder and separated from it by arbitrary survey-lines only. It is therefore, reasonable to assume that its average quality is substantially the same. Assuming this proportion, we have 268,000,000 tons for these claims, a total of 1,251,000,000 tons of ore with 50% of metallic units of iron and nickel.

It must, however, be borne in mind that the above tonnage represents the weight of the ore as it lies in the ground; while the analysis represents ore from which all moisture, both hygroscopic and combined, has been expelled. In addition to from 10 to 14% of combined moisture, the ore contains from 25 to 30% of hygroscopic moisture, a total of from 40 to 42% of water in the average ore. The tonnage of ore actually containing, when dried, 50% or more of metallic units, as calculated above, must, therefore, be taken at 60% of the total tonnage of ore in the ground in its natural state, or 750,000,000 tons.

This tonnage refers only to the ore developed by the explorations described above. There are some claims near the sea which I have not explored and the ore 15 miles inland I have not even visited. No attempt is made to estimate the additional tonnage these represent.

Commercial Availability.

Since there must be always two sides to the shield, it is not surprising that an ore, with so many features favorable to its commercial exploitation, should also present problems that involve extensive and painstaking experiment for their solution. Its clay-like consistency made it uncertain how it would act in the steam-shovel dippers or excavator-buckets, difficult to remove from cars by dumping, and practically impossible to stow in bins or any other device involving its removal from the bottom of the pile.

The high percentage of moisture, and the consequent transportation-charges and duties on 40% of water, necessitated drying the ore, and the extreme fineness of most of the dried ore made it necessary to carry the process further, and, by increased temperature, produce incipient fusion and convert the ore into nodules suitable for the blast-furnace.

In the furnace the high alumina-content complicated the slag-calculations; and once pig-iron was produced, the elimination of the chromium was essential to the production of satisfactory steel.

A detailed description of how these several problems have been met would form a paper of some length. It is sufficient here to say that the Pennsylvania Steel Co., the parent company of the Spanish-American Iron Co., has worked out practical solutions of all these difficulties in the case of the Mayari ores, and the results are applicable to the similar Moa ores.

At Mayari, the ore is handled by shovels, or by scraper-excavators, and does not cling to the dipper or bucket. Special railroad-cars capable of being tipped to an angle of 90° are used to transport the ore, which falls from the car, leaving the inner surface nearly clean. When the ore must be handled subsequently, this is done by grab-buckets from gantries or moving bridges. Kilns, resembling the ordinary cement-kiln, are used to produce nodules, which have proved highly satisfactory for use in the blast-furnace; and it has been demonstrated that a certain amount of undried ore can be mixed with the nodules in the furnace-charge without producing any abnormal amount of flue-dust. In spite of the high aluminum, the blast-furnace slag gives no trouble.

The part or complete elimination of the chromium and the production of a satisfactory steel were accomplished after patient experiment. Steel rails made from this ore have demonstrated their superiority over ordinary rails, by actual use on the Horseshoe Curve of the Pennsylvania R. R. For more than a year the Pennsylvania Steel Co. and the Maryland Steel Co. have manufactured commercially, from Mayari ore, a steel which, by reason of its nickel-content and low phosphorus, is superior to the ordinary Bessemer and open-hearth products.

HARBOR.—A safe and sufficiently large harbor is indispensable to successful exploitation. The so-called bay of Moa is apparently directly exposed to the prevailing trade-winds, but is in reality protected by a line of coral reefs which form an effective breakwater and render the harbor a safe anchorage for the largest vessels.

There is a wide entrance between the reefs, and soundings have shown the existence of deep water to within 1,000 ft. of the shore.

Character and Origin of the Ore.

[The following is an excerpt from a paper on the "Occurrence, Origin and Character of the Surficial Iron Ores of Camaguey and Oriente, Cuba," by Arthur C. Spencer, M. Am. Inst. M. E., of Washington, D. C., published in the March, 1911, "Bulletin" (No. 51) of the American Institute of Mining Engineers.—Ed.]

In considering the surficial iron-ores of Cuba, it is of interest to note that iron-ores occur in very similar relationship in various parts of the world. Indeed, such ores have long been known, and in many places have been used as a source of pig-iron.

In the United States, iron-ores of precisely similar composition forming surface-deposits over serpentine rock exist at Clealum, Wash., and at Richmond, Staten Island, in New York City. The Staten Island deposits, though now practically exhausted, were formerly mined and smelted. The Clealum ores occur in a region in which smelting would not be profitable because no cheap fuel is available for this purpose.

Similar ores in the same relationship to serpentine rock occur also on the island of New Caledonia, in Western Australia, and in several localities adjacent to the Mediterranean sea.

Deep and extensive surface-mantles of iron-ore occurring in India closely resemble the Cuban ores here under discussion in physical character and in the fact that they occupy elevated plains or plateaus, though in India the underlying rock is basalt and not serpentine. These deposits have been mined and smelted for hundreds of years by the natives of India, and are now reported as being developed under government auspices.

From the facts above stated, it is evident that ores of the nature of those occurring in the Cubitas, Mayari, and Moa districts have been long established among the different varieties of iron-ores, and cannot be considered properly under any other classification.

My conclusions concerning the origin of the surficial iron-ores of Cuba may be briefly stated as follows: These ores have been formed as a result of progressive and long-continued decay of serpentine rock under the dissolving and corroding action of atmospheric waters charged with carbonic acid gas. The ores are thus properly termed residual ores in the sense that they have originated in situ through the gradual wasting of the serpentine rock, the removal of its more easily attacked constituents, such as magnesia and silica, by a process of solution, and the consequent setting free of oxides of metals such as those of iron and aluminum, which are well known to be practically insoluble in reagents ordinarily found in nature.

The parentage of the surficial ores of Cuba in serpentine rocks like those upon which they lie is conclusively established by the presence of small percentages of chromium, nickel, and cobalt in the ores. These metals are characteristic constituents of serpentine rocks, as shown by analyses of serpentines collected in various parts of the world. Their presence in appreciable amounts has been established in the serpentines of Cuba and in similar rocks lying beneath the previously mentioned Staten Island and Clealum ores. The residual ores of these localities carry chromium and nickel as do those of Cuba.

The ores in question cannot be otherwise classified than as residual ores. That is, they represent the insoluble residue left by otherwise complete dissolution of serpentine rock under the action of atmospheric waters. They are to be set apart from that other class of superficial iron-ores known as bog ores, since the widely different origin of the latter is very different. Bog iron-ores are deposited in swamps and marshes from dilute solutions in which the solvent is ordinarily either an organic acid derived from decaying vegetation, or sulphuric acid produced by oxidization of iron pyrites. The precipitation from such solutions is known to be effected by iron-organisms which inhabit the waters of swamps and marshes, or by carbonization under reducing conditions in the presence of decaying organic matter.

Residual ores like those of Cuba and India are deposited in situ, while bog ores, which are characteristically of very limited extent, are mainly deposited at some distance from the source of the contributing iron, which involves transportation to the place of deposition in a dissolved condition. The residual ores of Cuba were formed in Tertiary time, in large part, and perhaps entirely, prior to the deposition of the Lafayette (Pliocene) formation of the Atlantic coastal plain. During the time of their accumulation the brown iron-ores of Alabama, Virginia, Pennsylvania and New York were being deposited, many occurrences of which are likewise recognized by geologists as being residual ores.

Transportation Costs.

[The following is an excerpt from a paper entitled "Exploration of Cuban Iron-Ore Deposits," by Dwight E. Woodbridge, M. Am. Inst. M. E., of Duluth, Minn., published in the March, 1911, "Bulletin," No. 51, of the American Institute of Mining Engineers.—Ed.]

Iron-ore is transported from Cuba to American Atlantic ports at 85 cts. per ton. It is carried in British and Norwegian tramp steel ships of from 3,500 to 6,000 tons cargo-capacity, usually equipped with two cargo-hatches forward and two aft. These vessels do not compare with the great lake-freighters of from 10,000 to 13,000 tons capacity and with from 20 to 33 hatches. To be sure, a lake ore-carrier would not live in the weather to which these boats are subjected, but there is no doubt that reasonably large staunch carriers can be so constructed as to afford rapid loading and unloading at each end of the route. With a ship of this character in this trade, more money could be made at 70 cts. per ton than the lake boats make at 85 cts. per ton.

Adding duties at 75% of the foreign import rate, incidentals, administration expenses, nodulizing, and all other charges, a nodulized 54% Bessemer ore can be delivered from these mines at American Atlantic ports at a cost of about 5 cts. per unit of iron, and at Pittsburg at a cost of 8 cts. per unit of iron, the additional 3 cts. being due to the freight from the seaboard to Pittsburg. The raw ore can be delivered at the same points at 3.5 and 7.2 cts., respectively. Of course Lake Superior ores have a counter and equivalent advantage at Pittsburg, as this Cuban product has at ocean ports, due to the cost of the rail-haul between that city and the sea.

Various important steel-making concerns are interested in the Moa region. The U. S. Steel Corporation has a number of men in that field; the Pennsylvania Steel Co. and the Bethelehem Steel Co. are also well represented by their subsidiary companies—the Spanish-American Iron Co. and Juragua Iron Co.; and other eastern and western interests are identified with the field. No mining has as yet been started at Moa, but it is probable that operations will not long be delayed.

INDUSTRIAL SCHOOLS IN WISCONSIN.—The Wisconsin Commission Upon Plans for the Extension of Industrial and Agricultural Training, has recommended to the Governor, the adaptation to Wisconsin conditions of the German system of compulsory continuation day schools. Under the German law, every state is allowed to establish continuation day schools in which attendance is required of all apprentices under 18 years of age; employers are compelled to allow the apprentices the time necessary for attendance. The apprentices are instructed in a wide range of subjects bearing on their trades. The Commission recommended the adoption of a law making industrial training compulsory for all apprentices in Wisconsin until the 16th year of their age, and setting the length of working day for all children under 16, at eight hours. The National Society for the Promotion of Industrial Education, 20 West 44th St., New York City, is distributing advance sheets of the Wisconsin Commission's reports.

The Pittsburg Meeting of the American Society of Mechanical Engineers.

The spring meeting of the above Society was held last week at Pittsburg, Pa. The convention headquarters were at the Hotel Schenley, and the meetings were held in the lecture hall of the Carnegie Institute, close by. The meeting was an unusually important and successful one, both with respect to the attendance—some 600 members and guests being registered—and the value and interest of the papers considered at the technical sessions.

Three afternoons were devoted to excursions to various industrial plants in the vicinity of Pittsburg, and a continuous round of pleasure was provided for the ladies in attendance at the convention. The entertainment of the visitors was in charge of a committee of the local members, headed by an executive committee made up of Mr. E. M. Herr, Chairman, Vice-President of the Westinghouse Electric Co., Messrs. George Mesta, ... M. Tate, Jr., D. F. Crawford, Chester B. Albree, Morris Knowles, and Elmer K. Hiles, Secretary.

The meeting was opened on Tuesday evening with an informal reception of the visitors in the Schenley parlors, at which one notable event was the presentation to the President of the Society, Col. E. D. Meier, of an engrossed testimonial expressing the high regard of the members of the Society for Col. Meier's professional attainments and personal character. The presentation was made appropriate by the fact that the day was Col. Meier's 70th birthday. Those joining in presenting this testimonial to Col. Meier have arranged to have his portrait painted.

The regular work of the convention began on Wednesday morning with the semi-annual business meeting. The only matter of particular interest taken up at this meeting was the report of a committee which presented a schedule of standard dimensions for flange pipe fittings of all sizes, from 1¼ ins. to 24 ins., both for standard weight pipe and extra heavy pipe. These standards were prepared jointly by a committee of the National Association of Master Steam and Hot Water Fitters and a committee of the American Society of Mechanical Engineers, the latter consisting of Messrs. Henry G. Stott, John H. Sparrow, William Schwanhausser, Walter M. McFarland and Albert C. Ashton. The standards will be printed and made available for those interested.

The Society is inaugurating a new departure in an endeavor to adequately cover a number of specialized fields of work, in which the mechanical engineer's work has become of great importance. Through the Society's Meetings Committee, special committees are being organized, each one of them having responsibility for a certain particular branch of mechanical engineering. The engineering of cement manufacture is one of these branches, and the morning was spent in consideration of a number of papers relating to this field.

The first paper, by Prof. Walter S. Landis, Associate Professor of Metallurgy, Lehigh University, discussed some general problems of the cement industry. Prof. Landis urged that the great reduction in the margin of price in the cement industry makes necessary the remodeling and rebuilding of the older plants, in order to achieve greater economies in production. Prof. Landis pointed out that the total heat actually required to produce the chemical reactions which take place in forming cement clinker could be furnished by about 16 lbs. of coal per bbl. of clinker. In contrast with this, the average fuel consumption of coal-fired cement kilns throughout the country is about 90 lbs. of coal per bbl. of clinker. Prof. Landis took issue with a recently published statement that cement production had been reduced to 33 cts. per bbl. as an actual mill cost. "The Lehigh region," said he, "is producing cement as cheaply as any district in the country, and we have to strive hard to get the total cost at the mill below 55 to 60 cts. per bbl."

The second paper, by Mr. W. H. Mason, Superintendent of the Edison Portland Cement Works at Stewartsville, N. J., described the Edison roll crushers and some interesting mechanical problems in connection with their development. These crushers are in use at the Edison cement plant and also at the Tomkins Cove Stone Co.'s plant, which was described in Engineering News of Jan. 12, last. In the original invention of these crushers, Mr. Edison was led to substitute mechanical energy for dynamite as a means for breaking up large pieces of stone by making a computation showing that the average mechanical energy in a pound of 50% dynamite was about equal to the mechanical energy available in the steam produced by burning a pound of pea coal. Comparing pea coal at $2.50 a ton with dynamite at $250 a ton would make the commercial advantage of the coal over the dynamite approximately about 100 to 1.

The third paper on the morning's program was by Mr. L. L. Griffiths, of Dallas, Tex., General Superintendent of the Texas Portland Cement Co. The paper described five different plants with which the author was personally familiar, and compared the relative efficiency of the different plants with reference to the distribution and utilization of power.

The discussion upon these papers was chiefly directed to questions as to the dust nuisance from cement plants. Many cement plants are experiencing serious trouble from land owners in the vicinity on account of the great volume of dust carried high into the air from their chimneys and distributed over the surrounding country. It was admitted that in many plants as much as 5% of the total output of the plant is scattered far and wide over the country in the shape of dust. Claims were made that the wet process of cement manufacture largely eliminates the dust. These claims were denied, however, but it was suggested that if the slurry was sprayed into the kiln against the current of hot gases that the greater part of the flying dust might be caught and saved by that method.

Readers of Dickens will remember that the famous schoolmaster Squeers, who appears to have been one of the pioneers in industrial education, illustrated his method to his new assistant, Nicholas Nickleby, by having a boy spell the word "horse" and then sending him out to curry off Squeers' own animal.

The Society having spent the morning hearing the subject of cement discussed, made a trip in the afternoon to visit one of the largest cement works in the world, that of the Universal Portland Cement Co. This huge plant, with a daily capacity of 12,000 bbls., is located, not like most of Pittsburg's great manufactories in the bottom of the crowded valleys, but back on the hills in the country, on the line of the Pitstburg, Bessemer & Lake Erie R. R., where it crosses from the Monongahela valley to the Allegheny.

The plant utilizes granulated blast furnace slag, brought from the Bessemer furnaces of the Carnegie Steel Co., and limestone, quarried near Butler, Pa., as its raw materials. The slag is granulated at the steel works by being discharged into water, and it comes to the cement works well saturated with moisture. Both the slag and limestone, after being crushed, are passed through revolving dryers preliminary to grinding. The entire plant is operated by electric power transmitted to it from the Carrie blast furnaces of the Carnegie Steel Co., where it is generated by gas-engine driven generators, using waste gas from the furnaces. The Universal Portland Cement Co., a subsidiary of the United States Steel Corporation, has now five plants in operation, and with the completion of the sixth plant, located at Buffington, Ind., will have an annual capacity for producing 12,000,000 bbls. of Portland cement.

After viewing the cement works the visitors returned to the special train which had brought them from Pittsburg and were taken to East Pittsburg, where a visit was made to the great works of the Westinghouse Electric Co. and the Westinghouse Machine Co. All that can be done by a visitor in a hasty view of such enormous plants, during the hour or two available for walking through them, is to merely glance at a few of the many interesting classes of work to be seen in progress. At the Westinghouse Electric works one of the things which attracted most attention from the visitors was the huge electric locomotives under construction for the Pennsylvania R. R. Co. for operating the tunnel terminal at New York City. The running gear of these locomotives is built at the company's works at Altoona and is then taken to East Pittsburg, where the electric machinery is built and installed by the Westinghouse Co. In the Westinghouse Machine works, the Westinghouse double-flow steam turbines and the Melville-McAlpin speed-reduction gear for steam turbines were among the things attracting greatest attention.

Returning to the hotel, the convention again assembled to discuss technical papers. The main body of the Society had for consideration a number of papers on the manufacture of small machinery, including the manufacture in quantity and the work of assembling the parts. The papers presented were by Messrs. John Calder, of the Remington Typewriter Works, Ilion, N. Y.; Halcolm Ellis, Inventor of the Ellis Adding Typewriter; F. B. Cox, of the General Electric Co.'s Meter Department at West Lynn, Mass., and Mr. A. L. DeLeeuw, of the Cincinnati Milling Machine Co. The paper by Mr. DeLeeuw recited experiments indicating that the efficiency of milling machines is increased by increasing the tooth space and depth.

While these papers were being discussed by the general Society, a session more largely attended and more exciting was held by the Gas Power Section in the hall of the Carnegie Technical Schools. One of the new departures in the Pittsburg district is the utilization of the gas from the blast furnaces for driving gas engines. Such gas engines are now working in the Pittsburg district at the Bessemer and Carrie furnaces and the Duquesne plant of the Carnegie Co., and at the McKeesport works of the National Tube Co. Gas engines are also in use at the Cambria Steel Co.'s works at Johnstown, at the Youngstown, Ohio, works of the Carnegie Co., and at the Homestead works.

Instead of having formal papers prepared with reference to these installations, a number of the engineers responsible for their installation and operation had been invited to discuss their experiences in connection with them. Those taking part included Mr. A. E. Maccoun, Superintendent of the Edgar Thompson Furnaces; Mr. R. H. Stevens, Mechanical Engineer at Homestead; Mr. A. N. Diehl, Superintendent of Furnaces at Duquesne, and Mr. A. L. Hoerr, of the National Tube Works.

From the reports presented by these gentlemen and others who took part in the discussion, it appears that the gas engines now running in the Pittsburg district are making remarkable records for both reliability and fuel economy. Fuel efficiencies were reported reaching as high as 30% of the total heat in the gas received converted into mechanical work. These engines are being run 24 hours a day, week in and week out, without shut downs, and are showing practically as great reliability as reciprocating steam engines used for blowing furnaces and developing electric power.

Nevertheless, it appeared to be the general opinion of the engineers of the Pittsburg plants that the final economy in dollars and cents of the blast furnace gas engine was no greater than that of the steam engine or the steam turbine. The fact that it utilizes the very low-value furnace gas as fuel is offset by the much greater first cost and consequent charges for interest and maintenance.

Added to this was the evident feeling that on account of the additional complications of the gas engine, there was greater risk in connection with it than attaches to the use of the steam engine. Bearing in mind the emergencies that occur at times in blast furnace work, it appeared to be felt that the extra anxiety involved

in the gas engine was not being compensated for by any real economy.

This opinion was very emphatically combatted, however, by Mr. H. J. K. Freyn, of the Illinois Steel Co. Mr. Freyn contributed an important paper to the Society at its Atlantic City meeting a year ago, describing the work done by blast furnace gas engines at a plant of his company in South Chicago, and is an enthusiastic believer in the economic advantage of the blast furnace gas engine. He declared that present charges against the gas engine are based on the high cost of the first engines built, and urged that with the greater experience in gas engine construction which is now accumulating, the gas engine will be improved and simplified and its cost reduced. At the same time, increases in fuel prices are inevitable. Pittsburg cannot permanently count on coal at $1 a ton.

In view of the fact that the use of blast furnace gas for developing power is universal in German steel works' practice and the day of difficulties is passed there, he argued that there was no question as to its superiority over steam for large plants. He admitted that for a small size furnace plant where there was no demand for electric power to utilize the surplus energy, the steam engine retained first place.

The discussion on the subject had finally to be cut short and the remaining portion of the evening—and very late evening at that—devoted to a brief presentation of the work being done by the Bureau of Mines at its Pittsburg Fuel-Testing Station.

The session on Thursday morning considered a miscellaneous set of papers. Prof. R. T. Stewart, of Pittsburg, who has already contributed a paper to the Society describing tests on the strength of tubes, described an investigation tending to show that the stresses in the wall of a tube exposed to extended fluid pressure are like those in a column with fixed ends.

Mr. D. T. Randall, of Boston, discussed the purchase of coal by specification, with particular reference to the methods of sampling and the relation of the quality of coal to the results obtained in furnace. In discussing the latter paper, members of the Society's Committee on Conservation criticized the present tendency toward the purchase of coal under strict specifications, because the tendency is to put a premium on the high-class coals and a penalty on the coals of second-grade quality. What the engineer responsible for the purchase of coal should do is to buy whatever coal will give the purchaser the best results in dollars and cents. Many plants find it advantageous to burn low-grade fuels and, by proper attention to the appliances for combustion, satisfactory results can be obtained from such fuels at a much lower cost than that necessary to pay for highest grade coal.

Prof. Forrest E. Cardullo, of Durham, N. H., presented a paper on the pressure drop between stages in compound steam turbines. He had developed a formula for determining the pressure drop, enabling the several stages of the turbine to be properly proportioned.

Prof. Lionel S. Marks, of Harvard University, had a paper on the pressure-temperature relations of saturated steam, summarizing for the Society the results obtained in the recent investigations of Scheel and Heuse and of Holborn and Henning. By these investigations the temperature corresponding to any pressure of steam between 1/10 of a lb. to 250 lbs. per sq. in., absolute, is now accurately known to within 1/20 of a degree Fahrenheit.

The final paper of the morning was by Dean Gardner C. Anthony, of Tufts College, Mass., and described a pressure-recording indicator for punching machinery obtained by supporting the die on a hydraulic cushion and measuring the pressure exerted on the cushion by the steam-engine indicator. Cards were obtained showing the work done and pressure exerted by various punches in punching plates of various thicknesses. In the discussion Mr. Julian Kennedy suggested that more accurate records can be obtained by applying the pressure to the punch through multiplying levers, similar to those of a weighing scale.

Thursday afternoon was devoted to a boat excursion on the Monongahela River and a visit to the new works of the National Tube Co., at McKeesport, Pa. These works, built about five years ago, extend along the front of the Monongahela River for over a mile and cover an area of about 100 acres. In these works tubes and pipes of all sizes, from ⅛-in. to 30 ins. in diameter, are produced from the raw materials, iron ore from the Lakes being reduced in four large blast furnaces with accessory steel plant, blooming and slabbing mills. One of the most impressive sights to the visitors was the 16-in. continuous rolling mill, in which slabs from the steel mill pass in continuous procession through successive chains of rolls, which gradually reduce its thickness and increase its length, until it is finally delivered, cut automatically to proper length, on a pile of glowing strips of skelp ready for delivery to the pipe mills.

The most interesting feature of the plant, however, is the huge mill built for manufacturing pipes and tubes, a structure covering 23 acres of ground, an area 1,600 ft. long and 600 ft. wide. It is said to be the largest building having one continuous roof in the world. The building contains twelve furnaces for making lap-weld pipe and six for butt-weld pipe. Both the lap-weld and butt-weld furnaces are able to produce pipes of 40-ft. lengths, the latter in diameters from 3 ins. to 12 ins., and even larger sizes have been made.

The visitors to the plant who were familiar with metallurgical works in general were especially impressed with the orderly arrangement of the machinery, the systematic movement of the material through the works and the special care taken to protect the workmen from danger of injury by moving machinery and material.

The return from the works to Pittsburg was made on a Monongahela River steamer, a type of vessel entirely novel to many of the visitors.

On Thursday evening occurred the usual reception by the President and officers of the Society, assisted by members of the local committee and their ladies. The reception was held in the large ball-room of the Schenley, and was attended by many prominent residents of Pittsburg.

The session of Friday morning, after the reading of papers, was devoted to matters of special interest to the Pittsburg steel manufacturers. Mr. Richard H. Rice, Manager of the General Electric Co.'s Lynn Works, described the new steam-turbine driven turbo-compressor developed by the General Electric Co., and put into use for blowing the furnaces of the Empire Iron & Steel Co., at Oxford Furnace, N. J. The machine is a six-stage turbine air compressor, operating at 1,650 r. p. m., and driven by a four-stage Curtis steam turbine on the same shaft. The normal blast pressure produced is 15 lbs. per sq. in. The machine is a great contrast in its size for a given output of air to the standard reciprocating blast furnace blowing engine. The most remarkable thing in connection with the apparatus, however, is the increase in furnace output obtained by its use. From an average output from the furnace of 139 tons pig iron for 24 hrs. in February, 1910, the introduction of the new blowers raised the output to 176 tons per day in April, and at present the production averages 185 tons. It is claimed that this increased output has been accompanied with an improvement in quality and that the reliability and overload capacity of the machine adapts it particularly to the necessities of blast furnace use.

Following this paper Prof. Willibald Trinks, of the Carnegie Technical Schools, presented a paper on reciprocating blowing engines for blast furnaces, which was a very notable review of recent design in this class of machinery, with particular reference to the valves used on the air cylinders. This subject is of equal interest in connection with the design or air compressors. Prof. Trinks traced the progress of design of air valves through various stages of evolution to the latest types of thin plate valves covering many port seats and having a limited lift. He showed that these valves were in extensive use in Germany, where they are giving entire satisfaction and are also coming rapidly into use in the United States. The advantage of these valves in simplifying the design of the reciprocating blowing engine, reducing its cost and increasing its speed, is so great that he thought this type of engine could hold its own against the rotary compressor.

The final paper of the session was by Dr. Berthold Gerdau, of Düsseldorf, Germany, and Mr. George Mesta, President of the Mesta Machine Co., of Pittsburg. Dr. Gerdau came from Germany to present this paper, which described recent work in hydraulic forging machinery. Dr. Gerdau is the inventor of a steam hydraulic forging press, which is built by the firm of Haniel & Lueg, of Düsseldorf, and is in extensive use in German metallurgical works, including the great Krupp Works at Essen.

In concluding the morning's session, the final adjournment of the convention, it was announced that the officers of the Society have selected Cleveland, Ohio, as the place of holding the spring convention of 1912. After the adoption of resolutions expressing the thanks of the Society to its Pittsburg hosts, final adjournment was taken.

In the afternoon a large proportion of the visitors took part in an excursion to the large new shops of the Mesta Machine Co., on the Monongahela River, where they were entertained at luncheon and shown through the shops. Among the notable machines inspected in the shops were a four-stage air compressor for the delivery of air at 1,000 lbs. per sq. in. in pressure, a 55-60-in. twin reversing engine for rolling mill work, a machine for cutting bevel and spur gears of large size, an electric motor-driven shear capable of cutting cold steel bars, 7 ins. square, and the 800-ton steam-hydraulic forging press, designed by Dr. Gerdau, and referred to above. In a large foundry connected with the machine shop, the visitors watched the tapping of an air furnace and the casting of a chilled roll, and the pouring of a heat of vanadium steel.

The concluding entertainment offered to the visitors was a smoker, given Friday evening by the Engineers' Society of Western Pennsylvania, in the Union Club on the top floor of the Frick Bldg. Mr. Geo. H. Nielson read "A Near History of Crucible Steel," devoted to the recital of many hitherto undiscovered and unsuspected facts, both metallurgical and personal.

The Pittsburg meeting will go on record as one of the most successful which the Society has ever held.

Conference of the National Housing Association.

The First National Conference on Housing in America was held in New York City, June 3, 5 and 6, under the auspices of the association just named. Mr. Robert W. De Forest, of New York City, President of the National Housing Association, served as Chairman of the Conference.

Papers on the various aspects of the housing question were presented and discussed. These included such topics as "City Planning" (paper by F. L. Olmsted), "Problems of the Small House," "Sanitary Inspection," "Garbage and Rubbish," "Alleys" and "Best Types of Small Houses."

A HOUSING PROGRAM.—The opening paper, which presumably to some extent set the key-note for the conference, was entitled "A Housing Program," and was presented by Mr. Lawrence Veiller, of New York City, Secretary of the National Housing Association. The author said that housing evils, which extend even to small villages, relate chiefly to unsanitary conditions. The universality of the housing problem indicates that it is founded on qualities inherent in human nature. While the various housing evils are found in nearly every city, generally some one of these evils predominates in any given city. Thus, in New York the greatest evil is dark

rooms, in Detroit it is alleys, and in Baltimore it is the 70,000 privies which still exist, although they will soon be abolished by the completion of a sanitary sewerage system. San Francisco, newborn within the last five years, now has more land overcrowding, including tenement evils and dark rooms, than any other city in the United States outside of New York.

Until recently, even the city officials of most cities were not aware of the bad housing conditions which existed in their midst. The newspapers were also equally ignorant. The first step in a housing reform campaign is an educational one. The evils can only be prevented through wise legislative control, and to secure these wisdom and tact are required.

It should be realized that, as a rule, city officials are as anxious for proper housing and good health conditions as the most ardent housing reformer. The people ask officials to do without tools—not money. New York City spends 17% of its municipal appropriations for its police and only 3% for its Health Department, which seemed to Mr. Veiller to be disproportionate.

City planning has a definite relation to housing reform, but housing reformers cannot afford to spend much time on city planning until many sanitary and related evils connected with housing are removed. As an illustration of ambitious city planning schemes being put ahead of housing reform, Mr. Veiller cited the millions which are being expended on the grand parkway between the Philadelphia City Hall and Fairmount Park, whereas the city is doing practically nothing to clear up its slum areas.

PRIVY VAULTS.—Mr. Charles B. Ball, M. Am. Soc. C. E., Chief Sanitary Inspector of the Chicago Health Department, presented a paper on privy vaults. After pointing out the general and some of the specific evils of vaults, Mr. Ball stated that the effect of these upon health and mortality, as well as statistics of the number of privy vaults themselves, are lacking throughout the country in general. From statistics collected by Mr. Burton J. Ashley, of Chicago, from about 40 cities, Mr. Ball presented the following examples, by way of illustration, no means of identifying the cities being given except as afforded by population figures:

Population.	Number of privy vaults.	Number of vaults for which sewers are available.
350,000	60,000	50,000
240,000	29,000	7,000
490,000	27,000	20,000
300,000	25,000	0
96,000	15,000	10,000
50,000	13,000	500
46,000	6,200	3,000

Mr. Ball remarked that Mr. Ashley and presumably other engineers have been giving particular attention of late to "the construction of individual septic tanks in small disposal fields," to serve private houses where public sewers are not available.

Where privy vaults are located below the ground surface, they should be either of brick or concrete, water-tight, with smooth inner surfaces. Concrete vaults "may be round or oval or with plain sides having rounded corners." Every underground vault should have its side walls carried at least 8 ins. above the ground surface to prevent the entrance of surface water. Small underground vaults are preferable in order to necessitate relatively frequent cleaning. The construction of the shelter house should be such as to make this possible without entering it.

Some of the "most careful sanitarians" advise the construction of privy vaults above ground to lessen dangers of soil pollution. Continuing this idea, Mr. Ball said:

> A number of cities, foremost of which is Washington, D. C., require that the privy vault should be provided with a platform, either of cement concrete, or of wood covered with metal, and having its surface at least six inches above the adjacent level of the ground. Upon this surface is placed a metallic box or pail or a wooden box lined with metal so as to be impervious. These receptacles are necessarily relatively small in size and it is claimed that the frequent cleaning thus imposed is an advantage rather than a disadvantage. The case with which the conditions of such appurtenances may be determined is a strong argument in favor of their use.

Shelter houses should be "screened and kept closed so as to prevent the access of flies and mosquitoes." Every effort should be made to eliminate privy vaults, and where water-closets are substituted they should be located within doors if possible. Where this is impossible,

> the next alternative is to locate a long hopper water closet close to the building with the floor of the compartment on the ground, so as to remove the trap of the closet as short a distance as possible from the bowl, and to arrange for the flushing from a tank placed within the house. The advantages of securing a tank flush combined with the opportunity of using a water closet rim which flushes entirely around the bowl are material as compared with the use of an iron hopper closet into which the water enters tangentially and the flushing effect is greatly dissipated. This arrangement of closet is common in Washington, D. C., but not elsewhere.
>
> The next type of fixture in point of desirability is a closet of the frost proof or non-freezing type, so-called, having an underground closed tank, or a tank located above the fixture into which the water enters only when the fixture is used. The objection to this kind of water closet, which has not yet, so far as I am aware, been overcome in any design, is the fact that freezing occurs when the flushing water comes in contact with those parts of the fixtures which are necessarily exposed to a low temperature. An additional disadvantage is the fact that it is found necessary in the case of an underground valve to provide a cross connection from the soil pipe to the water supply in order to allow the wasting of the water from the exposed portions of the apparatus. There is no doubt that such a connection is an element of danger whenever a loss of pressure or, as is sometimes the case a positive vacuum, occurs in the water supply mains, thus allowing the possible entrance of sewage matter into the domestic water supply system.

Finally, Mr. Ball advised that the cleaning of privy vaults should be performed by municipal day-labor forces, rather than by private contractors, thus obviating the necessity of an extra man to serve as an inspector, as the case in Chicago, to make sure that the work is properly done where it is entrusted to contracts or to private scavengers.

THE PASSENGER STEAMER "NORTH WEST," owned by the Northern Steamship Co., was heavily damaged by fire June 3 while moored to her dock at Buffalo, N. Y. Reports state that the interior of the boat was destroyed, leaving only the steel hull. The loss is estimated at $500,000. The fire is ascribed to an explosion of oil which occurred at 4 a. m. The "North West," together with her sister ship "North Land," was being overhauled for the initial trip to Chicago and Duluth.

A PASSENGER TRAIN WAS DERAILED June 2 on the Minneapolis, St. Paul & Sault Ste. Marie Ry. near Vergas, Minn. The wreck is ascribed to a washout of the roadbed. Eight of the eleven cars left the track and three of them were completely burned. One passenger, the wife of Mr. L. S. Berg, of New York City, President of the New Orleans, Mobile & Chicago Ry., was killed. Mr. Berg himself was seriously injured.

AN AEROPLANE RACE from Paris, France, to Rome and Turin, Italy, a distance of some 1,300 miles, was started on May 28. The contestants were allowed to start when they desired and to alight whenever they pleased. The race is to be completed by June 15. The prizes amount to about $100,000. Four of the contestants reached Rome by June 6, with Andre Beaumont, a Frenchman, in the lead.

The Paris-Madrid race (721 miles) was won by Pierre Vedrine on May 26, the time of the trip being 37 hrs. 27 min. He was the only contestant to finish, the others being stalled in the mountains until they were forced to abandon the attempt.

PUMPING OUT THE "MAINE" COFFERDAM around the wreck of the battleship in Havana Harbor, started on June 5 and was continued until the water level was lowered about 4½ ft. It is stated in the press reports that this level was held for ten hours without pumping, with a rise in interior level of only 1½ ins. No more pumping will be done for some days, so that the steel cylinders may take a set, due to the increased pressure upon them.

TELEPHONE TOLLS between the major parts of Manhattan and Brooklyn boroughs, New York City, have been ordered reduced from 10 cts. to 5 by the Public Service Commission after a long investigation of the local company's operation and condition. Corresponding reductions have been ordered for outlying districts. The voluntary acceptance of the order has not yet been filed by the company.

THE NEW CHICAGO TERMINAL STATION of the Chicago & Northwestern Ry. was opened for traffic on June 4. It is located at Canal and Madison Sts., with its main front on Madison St., the headhouse being a four-story granite structure 320 × 218 ft. There are entrances on three sides, while beneath the trainshed is a large concourse for suburban passengers, who may have access to and from the train platforms without passing through the main building. The train floor is elevated, and the 16 tracks spread out from a six-track approach, which diverges to the four-track approaches of two separate divisions. The trainshed is of the Bush type, with low arched spans of 39 ft. 3 ins. carried by rows of columns on the eight platforms and having over each track a longitudinal opening for the escape of smoke and steam. The present traffic is about 250 trains per day, but the station has a capacity for handling 1,200 trains daily. The total cost is given as $23,750,000, of which $11,550,000 was for real estate and legal expenses, $5,000,000 for the elevated approaches, and $6,380,000 for the station building and trainshed, and $5,000,000 for the elevated approaches. Mr. E. C. Carter, M. Am. Soc. C. E., is Chief Engineer; Mr. W. C. Armstrong, Terminal Engineer, was in direct charge of the work; Frost & Granger, of Chicago, were the architects.

A PNEUMATIC CONCRETE SPRAYING MACHINE for coating surfaces with concrete mortar has been sent to the Isthmus by the General Cement Products Company, and it will be tested for a period of 30 days in coating the surface of rock in Culebra Cut, for the purpose of preventing deterioration. Much of the rock in the Cut, which is hard and firm when first excavated, crumbles rapidly on exposure to the air.—Canal Record, May 24, 1911.

THE GOLD PRODUCTION OF THE TRANSVAAL in March, 1911, was 676,065 fine ounces, valued at about $14,000,000. This is about $317,000 more than the value of the output of December, 1908, which was the record monthly production.

Personals.

Mr. A. E. James, Assoc. M. Can. Soc. C. E., of Eglinton, Ont., has been appointed Highway Engineer of York County, Ont.

Mr. James R. Finlay, M. Am. Inst. M. E., of New York City, has been engaged by the State Tax Commission of Michigan to make an appraisal of the mining property of that state.

Mr. A. G. Whittington, formerly Division Superintendent of the International & Great Northern R. R., at Mart, Tex., has been appointed Superintendent of the Rio Grande Division of the Texas & Pacific R. R.

Mr. J. J. Swan, M. Am. Soc. M. E., formerly Sales Manager of the Keller Mfg. Co., of Philadelphia, Pa., has taken a position with the Chicago Pneumatic Tool Co., with offices at 50 Church St., New York City.

Mr. C. F. Loweth, M. Am. Soc. C. E., Chief Engineer of the Chicago, Milwaukee & St. Paul Ry., has been appointed Consulting Engineer of the Chicago, Milwaukee & Puget Sound Ry. in addition to his present duties.

Mr. J. Sergeant Cram, of New York City, a former Dock Commissioner of that city, has been appointed a member of the Public Service Commission of the First District of New York State, succeeding Mr. E. M. Bassett, whose term has expired.

Mr. W. H. Penfield, M. Am. Soc. C. E., formerly Engineer of Construction of the Chicago, Milwaukee & Puget Sound Ry., at Butte, Mont., has been appointed Assistant Chief Engineer of the Chicago, Milwaukee & St. Paul Ry. at Chicago, Ill.

Mr. Philip P. Farley, M. Am. Soc. C. E., President of the Jamaica Bay Improvement Commission, has been appointed Deputy Fire Commissioner of New York City. Mr. Farley was the Democratic candidate for State Engineer and Surveyor in 1908.

Mr. Kingsley L. Martin, M. Am. Soc. C. E., formerly Chief Engineer of the Bridge Department of New York City, and now Bridge Commissioner, has resigned his position with the city to become one of the principals of The Foundation Company, of New York City. His resignation takes effect June 15.

Mr. Arthur J. O'Keeffe, Deputy Fire Commissioner of New York City, has been appointed by Mayor Gaynor Bridge Commissioner, succeeding Mr. Kingsley L. Martin, M. Am. Soc. C. E., resigned.

Maj. E. E. Winslow, Corps of Engineers, U. S. A., formerly in charge of the harbor defense works at Honolulu and Pearl Harbor, Hawaii, has been selected by the War Department to superintend the location and erection of the Panama Canal fortifications.

Mr. E. O. Reeder, formerly Assistant Chief Engineer of the Chicago, Milwaukee & St. Paul Ry., has been appointed Chief Engineer of the Chicago, Milwaukee & Puget Sound Ry., at Seattle, Wash., succeeding Mr. E. J. Pearson, M. Am. Soc. C. E., who has resigned as noted in our issue of last week.

Mr. P. B. Motley, M. Can. Soc. C. E., Assistant Engineer of Bridges of the Canadian Pacific Ry., has been promoted to the position of Engineer of Bridges, succeeding Mr. Chas. N. Monsarrat, M. Can. Soc. C. E., who was recently appointed Chairman and Chief Engineer of the Board of Engineers of the Quebec Bridge.

Mr. William D. Bullock, M. Am. Soc. C. E., Assistant Engineer, in charge of Bridges and Harbor, City Engineer's Office, Providence, R. I., has been appointed Chief Engineer of the State Harbor Commission. The state has recently purchased 170,000 sq. ft. of property in Pawtucket for the construction of a state wharf.

Mr. L. S. Berg, President of the New Orleans, Mobile & Chicago R. R., was seriously injured, and his wife was killed, in a railway wreck near Vergas, Minn., on the Minneapolis, St. Paul & Saulte Ste. Marie R. R. on June 2. Mr. and Mrs. Berg were en route to Winnipeg in their private car. The train was derailed and three cars, including Mr. Berg's, were burned.

Dr. George B. Young, for many years in the United States Marine Hospital Service, and for the past six years in charge of the Chicago hospital of that service, has been appointed Commissioner of Health of Chicago, Ill., succeeding Dr. William A. Evans. Dr. Young has been granted leave of absence from his government position. His salary will be $8,000 per annum.

Mr. William L. Thompson, Assistant Engineer on the Panama Canal in charge of the Las Cascadas office, has been transferred to the Pacific Division on work in connection with hydraulic operations below the Miraflores Locks. Mr. Mark W. Tenney, Assistant Engineer in charge of the Paraiso office, has been transferred to the office of the Resident Engineer at Empire. The engineering department of the Central Division has been reorganized and the offices at Paraiso and Las Cascadas have been abolished. The field and office work formerly handled at these offices will be centralized in the Division Engineer's office at Empire, under the direction of the Resident Engineer and one Assistant Engineer.

Mr. Gustav Lindenthal, M. Am. Soc. C. E., Vice-President of the Institute of Consulting Engineers, of New York City, has been honored by the Rector and Senate of the Polytechnic School of Dresden, Germany, which has conferred upon him the title of Doctor of Engineering. This is the first time that this distinction has been bestowed "honoris causa" by a German Polytechnic School upon an American engineer. Two years ago the Austrian Society of Engineers and Architects, the leading technical organization of the Austrian Empire, elected Mr. Lindenthal a Corresponding Member, that society having no honorary members. Nicola Tesla and Gustav Lindenthal are the only two American engineers who have been thus honored by the Austrian Society.

Mr. Edward M. Bigelow, M. Am. Soc. C. E., of Pittsburg, Pa., has been appointed State Highway Commissioner of Pennsylvania under the Sproul Main Highway bill, which has now become a law. Under the provisions of this bill the Governor appoints a Highway Commissioner, two Deputy Commissioners, a Chief Engineer, Chief Draftsman and Superintendent of Highways, with numerous assistants and engineering staff. The legislation carries an appropriation of $4,000,000 for the immediate use of the Commissioner until the proposed bond issue of $50,000,000 can be provided for by constitutional amendment. Mr. Bigelow is a native of Pittsburg and studied civil engineering at the Western University of Pennsylvania. Under his direction as City Engineer and as Director of Public Works, many of Pittsburg's sewers, water mains and parks have been constructed and developed. His present appointment is for four years at a salary of $8,000 per annum.

Mr. John W. Kendrick, M. Am. Soc. C. E., Vice-President in charge of operation of the Atchison, Topeka & Santa Fe Ry., has resigned. Mr. Kendrick is a graduate in civil engineering of the Worcester Polytechnic Institute and entered the railway service in 1879 as a rodman on the Yellowstone Division of the Northern Pacific Ry. Since that time he has followed railway work continuously. For five years he was Chief Engineer of the Northern Pacific Ry., after which he entered the operating department as General Manager for the receivers of the same road and of the reorganized road, later becoming Vice-President in charge of operation. In 1901 he took charge of the operating department of the Atchison, Topeka & Santa Fe Ry. as Third Vice-President, and has remained in charge of that department as Second Vice-President and as First Vice-President. In December of last year Mr. Kendrick was granted a six months' leave of absence to regain his health. Mr. W. B. Storey, M. Am. Soc. C. E., Vice-President in charge of construction, who has temporarily performed Mr. Kendrick's duties, has been made Vice-President in charge of operation also, the two departments being now placed under one head.

Engineering Societies.

COMING MEETINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 6-10. Annual convention at Glen Summit Springs Hotel, Luzerne Co., Pa. Secy., Joseph Struthers, 29 West 39th St., New York City.

AMERICAN WATER WORKS ASSOCIATION.
June 6-10. Annual convention at Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charleston, S. C.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 19-23. Annual convention at Boston, Mass. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 13-16. Annual convention at Chattanooga, Tenn. Secy., Charles W. Hunt, 220 West 57th St., New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-16. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 19-21. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19-23. Annual convention at Boston, Mass. Secy., P. W. Drew, M., St. P. & S. S. M. Ry., Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 21-24. Semi-annual meeting at Chicago, Ill. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 26-30. Annual convention at Chicago, Ill. Secy., Ralph W. Pope, 33 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 27-29. Annual meeting at Pittsburg, Pa. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN CHEMICAL SOCIETY.
June 28-July 1. Annual convention at Indianapolis, Ind. Secy., Charles L. Parsons, Durham, N. C.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 6-8. Semi-annual meeting at Chicago, Ill. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 25-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

ENGINEERS SOCIETY OF PENNSYLVANIA.—The annual convention which was to have been held at State College, Pa., June 7-10, has been postponed to a date to be set later, probably in October.

NEW ENGLAND WATER WORKS ASSOCIATION.—The June outing will be held at Nantasket Beach June 14. A party of members and guests will go by boat from Boston to Nantasket, where dinner will be served at 1 p. m. The party will return to Boston in the evening.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting in New York City June 7, the following papers were presented for discussion: "Two Earth Dams of the U. S. Reclamation Service," by D. C. Henry; "Steel Centering Used in the Construction of the Rocky River Bridge, Cleveland, Ohio," by Wilbur J. Watson.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The name of the institute will be changed to "American Institute of Mining and Metallurgy" if a recent recommendation of the council and the board of directors is accepted. It is held that the proposed name more truly represents what the institute stands for than does the present one. The proposal will be submitted to the entire membership for ballot.

The council and board of directors have decided in favor of the establishment of local sections of the institute and have already authorized the formation of sections in New York and in San Francisco.

AIR BRAKE ASSOCIATION.—The 18th annual convention was held at the Auditorium Hotel, Chicago, May 23 to 26. A paper on "Brake Cylinders and Connections," by H. A. Wahlert dealt with the question of brake cylinder leakage in relation to packing leathers, packing expanders and the lubrication of the cylinder. It was stated that owing to the improvement in the manufacture of the leathers some leathers are in good condition after having made 160,000 applications. The author was not in favor of the use of expanders. The paper was accompanied by numerous details of tests of packing leathers. In a paper on "Adequate Braking Power for Freight Cars," Mr. John P. Kelly advocated an advance beyond the present practice of making the braking power equal to 70% of the light weight of the car. He proposed 35% of the loaded weight, which would be equivalent to about 120% of the light weight. A paper on "Running Triple Valves without Lubrication," by Mr. Lincoln Leonard, showed the necessity of avoiding an excess of lubricant and the advantages of using a dry lubricant instead of oil or grease. A paper on "The Strength of Foundation Brake Gear," by Mr. George O. Hammond, was of a mathematical character, illustrating the methods employed in the design of the various levers, bell cranks, etc. The "Friction of New and Worn Brakeshoes on New and Worn Cast Iron Wheels," was discussed by Mr. A. S. Williamson, in regard to the variation in coefficient of friction. A long paper by Mr. W. V. Turner on "The Problem of Controlling Modern Passenger Trains" related to the advantages of what is known as the "P. C." equipment for securing a graduated release. This special equipment for passenger train service was developed after a series of brake tests made on the Lake Shore & Michigan Southern Ry. in 1909. The apparatus and its operation were described in detail. Each car has two brake cylinders; only one operates in service applications, but both operate in emergency applications of the brake.

AMERICAN SOCIETY FOR TESTING MATERI... The program for the annual meeting at the Hotel ... more, Atlantic City, N. J., June 27-July 1, is as ...

Tuesday afternoon—Committee reports on "St... rd Specifications for Cast Iron and Finished C... Walter Wood, chairman; "Standard Specificati... for Hard-Drawn Copper Wire," J. A. Capp, ch... n; "Standard Specifications and Tests for Clay and ... nt Sewer Pipes," Rudolph Hering, chairman; "St... ard Specifications for Paving and Building Brick," ... E. Douty, chairman.

Tuesday evening—Presidential address on "The ...erican Society for Testing Materials," Henry M. ... we; "The Manufacture of Pure Irons in Open-Hearth ...rnaces," Allerton S. Cushman; "Measured Strains ... Engineering Structures," James E. Howard; "A ... of the Heat Treatment of Some Low-Carbon Nickel ...," Henry Fay and John M. Bierer; "Flue Sheet ... Cause of Formation in Locomotives," Robert ...

Wednesday morning, general subject, Steel—C... ittee reports on "Standard Specifications for Steel," ... am R. Webster, Chairman; "Heat Treatment of ... and Steel," Henry M. Howe, Chairman. Papers: ... rain-Size—A Function of Both Time and Temperature," Henry M. Howe; "On the Heat Treatment of a Nick... Steel," Wm. Campbell and H. B. Allen; "A Comparis... of the Properties of an Acid and a Basic Open-Hearth ... el of Similar Composition," Henry Fay; "Studies ... Steel Tires," Robert Job and Milton L. Hersey; "Th... ity in Rail Steel," P. H. Dudley.

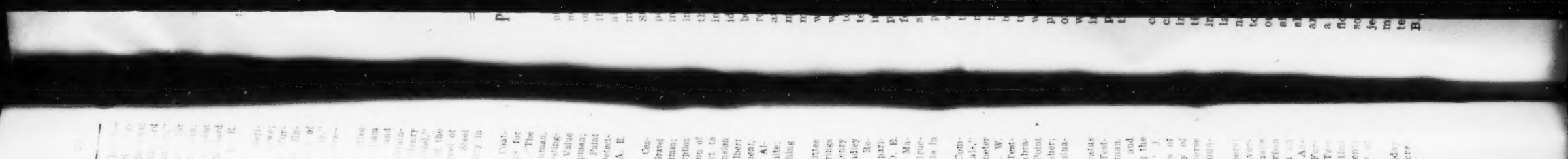
Wednesday evening, general subject, Preserva... Coatings—Committee reports on "Preservative Co... s for Structural Materials," S. S. Voorhees, chairm... "The Corrosion of Iron and Steel," Allerton S. ... nman, chairman. Papers: "Further Results of the ...estinghouse, Church, Kerr & Co. Paint Tests" and "The Value of the Sulphuric Acid Corrosion Test," C. M. ...apman; "The Practical Testing of Drying and Semi-Drying Paint Oils," Henry A. Gardner; "A Novel Method of Detecting Resin Oil and Mineral Oil in Other Oils," A. E. Outerbridge, Jr.

Thursday morning, general subject, Cement and Concrete—Papers: "Practical Tests of Sand and Gravel Proposed for Use in Concrete," Russell S. Greenman; "Some Experiments on the Incrustation and Absorption of Concrete," Abel O. Anderson; "The Determination of Stresses in a Reinforced Concrete Member Subject to Axial Load in Flexure," S. Ingberg; "The Expansion and Contraction of Concrete While Hardening," Albert T. Goldbeck; "The Properties of Magnesium Cement, Mortars and Concretes," C. Derleth, Jr., and A. C. Alverez; "Disintegration of Concrete," Alfred H. White; "The Effect of High-Pressure Steam on the Crushing Strength of Concrete," Rudolph J. Wig.

Thursday afternoon, general subject, Steel—Committee report on "The Tempering and Testing of Steel Springs and Standard Specifications for Spring Steel," Henry Souther, chairman. Papers: "Hardness Tests," Bradley Stoughton and J. S. Macgregor; "Hardness in Its Relation to Other Physical Properties" and "A Comparison of Fire Methods of Hardness Measurement," D. E. Douty; "The Property of Hardness in Metals and Materials," Albert F. Shore; "Strength of Steel from Structural Shapes," E. L. Hancock; "Recent Developments in Testing of Boiler Tubes," F. N. Speller.

Friday morning, general subject, Bitumens, etc.—Committee report on "Standard Tests for Road Materials," L. W. Page, chairman. Papers: "A New Consistometer for Use in Testing Bituminous Road Materials," W. W. Crosby; "Improved Instruments for the Physical Testing of Bituminous Materials, Paper III.," Herbert Abraham; "A Proposed Method of Testing the Melting Point and Softening Point of Compounds," Henry W. Fisher; "Organic Residues from Soluble Bitumen Determinations," Prévost Hubbard and C. S. Reeve.

Friday afternoon, general subject, Testing Apparatus and Methods—Committee report on "The Magnetic Testing of Iron and Steel," Charles W. Burrows, chairman. Papers: "Standard Methods for Testing Sewer Pipe and Drain Tile," A. Marsten; "A New Method of Testing the Endurance of Case-Hardened Gears and Pinions," J. S. Macgregor and Bradley Stoughton; "New Types of Impact Testing Machines for Determining Fragility of Metals" and "A New Type of Autographic Transverse Testing Machine for Research Testing or Regular Foundry Practice," T. Y. Olsen.

Saturday morning, miscellaneous subjects—Papers: "The Fritz Engineering Laboratory of Lehigh University," Frank P. McKibben; "The Variation of Tensile Strength with the Percentage of Carbon in Iron-Carbon Alloys," C. R. Jones; "The Effect of Copper in Iron in the Acid Corrosion Test," W. H. Walker; "Recent Analyses of Tests on Structural Timbers Made by the Forest Service," McGarvey Cline; "The Brinell Ball Test Applied to Wood," W. K. Hatt; "Notes on Anti-Friction Alloys," Wm. Campbell; "Some Further Experiments Upon the Absorption, Porosity and Specific Gravity of Building Brick," D. E. Douty and L. L. Beebe.

Wednesday afternoon, Thursday evening and Friday evening have been reserved for social features and recreation.